Spatial Configuration Analysis:
Revealing the Underlying Spatial Structure of Single-Family Homes on Oahu

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We certify that we have read this Doctorate Project and that, in our opinion, it is satisfactory in scope and quality in fulfilment as a Doctorate Project for the degree of Doctor of Architecture in the School of Architecture, University of Hawai'i at Mānoa.

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Abstract

This project is a commentary on the disconnect between domestic space and cultural values on Oahu. Space Syntax is a method of analysis used in this study to reveal the underlying spatial structure of the home environment. It concerns spatial relationships and the manner in which they are configured to reflect or influence culture. Many of the configuration characteristics of the standard Oahu home are found to be inconsistent with local cultural values. The analysis reveals an underlying spatial structure that is segregated from outdoor spaces and inappropriately formal in nature. It also identifies spaces that are consistently structured contradictory to their actual uses. Configuration analysis reveals much about the Oahu home that is not immediately apparent and can serve as a useful tool to those involved in the design and building process.

Introduction

The evident disconnect between the architecture and culture of Oahu's domestic environment lies in its underlying spatial structure. Spatial configuration analysis reveals this underlying spatial structure and identifies the configurational parameters that define it. This study proposes that the standard single-family home on Oahu is structured on configurational parameters that do not appropriately correlate to local cultural values.

Oahu homes are largely segregated from the exterior and have a considerably formal structuring of space. Despite the unfeasibility of a precise definition, local culture is commonly thought to be closely linked to the outdoors and casual in nature. Furthermore, many of the spaces in a standard Oahu home are not appropriately structured for its actually use – namely the carport, kitchen, and the hallway.

The majority of pre-industrial house forms are thought to be vernacular in nature in which its users are often directly involved with the building process. Building knowledge is handed down through generations, evolving over time and bringing it closer to the cultural context in which it exists. The end of tradition in building, the beginning of institutionalization, marks the decline of vernacular architecture. With industrialization, the disconnect between inhabitant and house form grew into what is presented here as domestic environments that are inappropriate to the present day cultural context of Oahu. To understand the progression of this disconnect, it is important to understand the evolution of the American single-family home to became what it is today.

Despite a rich local culture, the majority of homes on Oahu are merely variations on a generic design model indifferent to local cultural values. Part of the problem can be attributed to the displacement of users from the design and building process. Many homes on Oahu are part of master planned communities built by large scale developers that have little interest in cultural concerns. Others are previously owned homes that were built with minimal attention to the cultural background of its current occupants. As with other aspects of design, spatial configurations of domestic environments are hardly determined by its users and, more importantly, their cultural background. By identifying the disconnects between domestic spatial structures and local cultural values, Oahu homes can be designed and built to be more appropriate to the lifestyle of its users.

This study is a commentary on the current state of Oahu's domestic environments. It focuses on spatial relationships rather than the aesthetic, material, or technical considerations of architecture. The intent is to call attention to the social-spatial dimensions of the domestic environment. It involves research into methods and principles of spatial configuration analysis and application of those methods and principles. The basis for the analysis is founded in Space Syntax, a set of techniques for the analysis of spatial configurations of various types. It was developed by Bill Hiller and his colleagues in the 1980s.

The objective of this study is to identify the nature of specific configuration parameters characteristic of homes on Oahu that are incongruent to the island's cultural context. This is accomplished through the application of Space Syntax techniques and principles in the analysis of a sample of single-family homes on Oahu. A sample of 10 single-family homes are analyzed, and their underlying spatial structures are made apparent. Social meaning can be interpreted from this analysis based on the principles of Space Syntax. The derived social characteristics are evaluated against local cultural values to determine the nature of disconnect between the underlying spatial structure and the more explicit cultural context. Analysis is also conducted on a selection of domestic environments from different cultural contexts that are thought to be relevant to the study and serve as markers for comparison.

This study is organized into five chapters. Chapter one provides a brief understanding of how the American single-family home became what it is today. It also gives an idea of some of the general conditions of present day domestic environments on Oahu. Chapter two explains Space Syntax on which this study is largely based. Some background information is given, and the method of analysis is detailed. Chapter three is the application of configuration analysis on a sample of single-family homes on Oahu. Chapter four applies the method of analysis on several examples meant to serve as comparisons for the Oahu sample. Chapter five summarizes the results of the analyses and draws conclusions on the social implications associated with the sample analyzed.

Chapter One: Evolution of the American Home

It is important to understand how the conventional single-family home evolved. This section takes a look how the American home has evolved into what it is today and the social and cultural influences that helped shape it. The following is primarily drawn from *American Home Life, 1880-1930: A Social History of Spaces and Services* by Jessica Foy and Thomas Schlereth.

Social and cultural influences shape patterns of living. In the United States, the Industrial Revolution played a central role in changing the domestic environment during the first half of the 19th century. Technological advances, urbanization/suburbanization, and the middle class growth were all products of the Industrial Revolution, which continued its influence on American home life until the early 20th century.

Suburbs developed in the United States with the beginning of the Industrial Revolution. In the 17th and 18th century, farms and businesses were run by extended families who lived adjacent to their shops. This changed with the Industrial Revolution. The United States shifted from an agriculture-based economy to manufacturing and production. As industries grew and factory jobs became widely available, the American population moved from farms to cities. The large influx of people eventually created problems of overcrowding and disease in many cities. The emergence of the suburb was a response to some of these problems. By the mid 19th century, the middle class was moving into the suburbs (Foy and Schlereth 25).

The Victorian Home and the Bungalow

At the same time, the Victorian culture was making its way into the American household. It was a highly structure, regimented, possessive, and class-sensitive lifestyle. Ideas of gentility and cosmopolitanism were high values. Many aspects of the Victorian culture originated from the upper-most sectors of society. It stressed individual cultivation and social display, and required rooms and furnishing designed for that purpose (Foy and Schlereth 54).

The decline of the Victorian Culture was paralleled with the decline of the parlor room. Other rooms related to formal entertaining and servants also became obsolete (Foy and Schlereth 27). With the passing of the Victorian house type came the popularity of the Bungalow. It was a product of the Arts and Craft Movement that took place at the turn of the century. The bungalow was a reaction to the formality and superficiality of the Victorian home (King).

Bungalows are single story houses. The Bungalow house type has open plans where public rooms flow together. The separation of the public and private functions characteristic of Victorian homes was no longer clearly identified. Popularity of the bungalow persisted until the 1940s even with the fading of the Arts and Crafts Movement.

The bungalow style was not the only option available to homeowners. Colonial Revival, Art Deco, Modernism, and Post Modernism strongly influenced domestic architecture in the 20th century. The significance of the Bungalow style, however, is that it reflected a dramatic change in American culture. The use of space at home has also changed very little since the emergence of the Bungalow as a mode of domestic living (Foy and Schlereth 66).

The Arts and Craft Movement was somewhat of a reaction to the effects of the Industrial Revolution and the Victorian culture. By the turn of the century, the American home and its furnishings were dramatically simplified. In addition, the collection of over-embellished goods made available by the Industrial Revolution to the middle class was being abandoned (Foy and Schlereth 26).

Homes of the 20th Century

The layout of upper class homes of the 1900s followed a well established plan. On the first floor were the family living rooms and formal reception rooms. The upper floor accommodated the bedrooms, dressing rooms, and nurseries. The servants' sleeping quarters were located in the attic. The basement held the servants' living area, kitchens, store rooms, pantries, and wine cellars (Bond 8).

Upper class families often owned a country house and a town house. The family country house was usually felt to be the real home. Most country houses were two or three times larger than town houses. Country homes tend to change very little. Modern forms of lighting and heating were slowly introduced in the country side (Bond).

The Industrial Revolution created a growing middle class and a rural to urban shift in society. Middle class homes were being built in the 1900s to resemble its predecessors, Victorian homes of the upper class. Flats and apartment living were also being established. The largest market of all for new homes was the suburban house for the middle to lower middle class (Bond 12).

Land in suburbs closer to the city was more expensive. Unlike the larger houses at the outer suburbs that had grounds rather than front and back gardens, homes located closer to the city had smaller gardens and were visible from the street. The front gardens were shorter, and the larger more pleasant gardens were at the back of the house. Cheaper houses had to be built much closer together with tiny front gardens where there were only a few paces from the garden gate to the front door (Bond).

Poorer homes of the 1900s were only a little better than the horrifying conditions of the early Industrial Revolution. They usually had a small front room or parlor, a kitchen/living room, and two or three small bedrooms. Few of these houses had bathrooms. Baths were taken in a tin tub in front of the kitchen fire. Lavatories were usually outside the main house, attached or across the small backyard (Bond 15).

Larger homes had a library, morning room, dining room and drawing room. In some houses the 'boudoir' was a kind of limbo room for the lady of the house half-way between the living room and the bedrooms. "A boudoir is similar to the morning room but on the principle and scale of a strictly private instead of a more public room; it is also practically the mistress's business-room from which the household management is directed and a particularly methodical lady may have a sort of office table or secretaire for a conspicuous feature, otherwise it may be merely a very dainty retreat for refined seclusion," (Bond 24).

Middle class houses contained a lot of bedrooms by today's standards. Having six family bedrooms and two attic rooms for the maids was typical. Families tended to be large compared with later generations. A family of four to six children was considered average. Bedrooms in the 1900s were lighter looking, walls painted in paler colors, wallpaper less overpoweringly patterned. Heavily built late-Victorian wardrobes, chests of drawers, and the high-standing beds with brass bedsteads were gradually replaced by lighter looking bedroom suites in modern or reproduction design (Bond 24).

Prosperous homes with a large family shared one bathroom and one lavatory with an extra lavatory outside for servants' use. Compared to other rooms, bathrooms were given little attention in the 1900s. They were regarded as rooms for attending to functional necessities not to be lingered in longer than necessary. According to *The Book of Homes* the minimum size for a bathroom was 8' x 10' with a separate tiled alcove for the bath and lavatory. Impressive kitchens and bathrooms designed as features of the house were several decades away in the future. Most kitchens in the early 20th century were functional and utilitarian, rarely seen by visitors (Bond 26).

Working class homes had only one modest size living room, also referred to as the front parlor, that was well maintained but only used for special occasions. The kitchen served as the family living room with a couple of fireside chairs, a sideboard, and a table for family meals or for working on. The kitchens also had an adjoining back kitchen that extended out in back of the house. Walk-in pantries were built adjacent to the main kitchen or back kitchen. In many respects, life in the home was more family oriented than in recent decades. More children, fewer manufactured entertainment, and more involvement in group activities encouraged a family oriented household (Bond 31).

The Living Room

The living room is a descendant of the Victorian parlor. The Victorian parlor served as a room for formal social functions during the mid 19th and 20th century. It evolved from a combination of the parlor and the drawing room of affluent 18th century households. The multipurpose parlors of this time were rooms used to receive guests. After greetings were exchanged, the men would remain in the parlor while the women withdrew to the drawing room for their own conversations. It was in the drawing room that guests were entertained.

By the mid 19th century, the parlor made its way into the middle class household. This reflected the growing significance of performing social ceremonies amongst the middle class. The middle class parlor functioned differently from its multipurpose predecessor. The modern parlor of this time was the setting for many formal social functions. Some were borrowed from the elite, such as theatricals and formal callings. Social functions that previously took place in old fashioned multipurpose parlors were given much more significance because they were now set in a room that was intended solely for such purposes. These social functions included weddings, funerals, visits from local dignitaries, and household celebrations. The middle class parlor was the main center of Victorian social life in the second half of the 19th century and was the focus of much expenditure and care (Foy and Schlereth 53).

Public and private spaces were clearly defined and separated in Victorian houses of the second half of the 19th century. Public spaces were typically located at the front of the house, and utilitarian spaces in the rear (Foy & Schlereth 51). Rooms designated “public” expressed the family’s cultural values to guests and visitors. They were the most significant rooms of the house and given the most care and attention. Large houses had many single-purpose rooms designated “public,” including libraries, music rooms, and conservatories. Each expressed a different aspect of the family’s cultural values. Libraries were indications of literary and scientific learning; music rooms expressed interest in the performing arts; and conservatories demonstrated a connection with nature (Foy & Schlereth 58).

Smaller houses had only one or two public rooms for social functions, typically a parlor and a dining room. The family’s display of culture was compressed into the parlor in these cases. Formal social life, cultured learning, and domesticity were all embodied in this culture. Consequently, photographs of such parlors can look cluttered and chaotic (Foy and Schlereth 59).

The parlor began to simplify by the 1890s. By 1910, the idea of the living room was widely promoted in favor of the parlor. Eventually it had completely replaced the parlor. The Victorian lifestyle was in decline with the disappearance of the parlor, although some families still used the living room as they once did with parlors. The term *living room* previously referred to a multipurpose room in small, very modest households. Now it refers to one principal room used by both family and guests (Foy & Schlereth 63).

By the 1920s, American families had less room to live in, and function-specific rooms of the Victorian era gradually gave way to the living room. New and expensive lighting, heating, and plumbing systems were now available, and living space was gladly sacrificed for these new amenities. Newly built houses were smaller and more expensive (Foy and Schlereth 64).

The Bedroom

The bedroom is often thought of as the archetype of domestic private space. Its primary function is for the purpose of sleep. However, bedrooms of the 19th century were also settings for many activities and cultural expressions unrelated to sleep. Furthermore, they were not always explicitly designated as private spaces (Foy and Schlereth 120).

Houses built in the 17th and 18th century typically included a bedroom linked to prominent social rooms on the ground floor. The ground floor bedroom had multiple entrances that often led from a parlor, entrance hall, or kitchen. Although it sometimes served as a sickroom, the ground floor bedroom was usually occupied by the head of the household. The location of the ground floor bedroom was positioned for sociability and provided the head of the household connection with ongoing household tasks. They were also furnished with chairs, couches, and tables for receiving visitors. This attributed a very public quality to the bedroom. All other bedrooms, servant quarters, and nurseries were located on the second floor (Foy & Schlereth 121).

By the mid 19th century, the importance of privacy outweighed the use of a ground floor bedroom. In affluent households, *all* bedrooms were located on the "chamber floor," clearly separated from the public spaces of the house. Unlike the earlier ground floor bedrooms, they had only one entrance that led from a discreet corridor. This 19th century trend started by the wealthy eventually made its way into the middle class home by the early 20th century. These changes reflected an increasing consideration for function (Foy & Schlereth 121).

Single-floor homes of the later 19th to early 20th century were also making clear distinctions of privacy in the location of bedrooms. Earlier apartment units and single-floor houses often linked a bedroom with the parlor and other public spaces. The remaining bedrooms were usually located along a corridor that led to the kitchen in the back. This type of layout provided very little privacy as family members, servants, and guests all pass the bedrooms on the way to the parlor, dining room, or kitchen. Furthermore, bedrooms along the corridor were often linked by a doorway. Toward the end of the 19th century, however, the boundaries between public and private spaces in single-floor homes were clearly defined. Family bedrooms were grouped together in a private area away from the public spaces of the house (Foy & Schlereth 123).

The changes in bedroom locations toward the segregation of public and private spaces and clarification of room use was evident in turn-of-the-century homes. This trend however, was counteracted by the Bungalow house type, where bedrooms often opened directly into the living and dining room. The Bungalows that became popular in the early 20th century again blurred the boundaries between public and private spaces in the home (King).

The Single-Family Home Today

The single-family home is the most prevalent form of housing on Oahu today. Nearly half, 47%, of housing units on Oahu are single-family homes ("Honolulu County, Hawaii - Selected Housing Characteristics: 2006-2008").

Despite a rich local culture, the majority of homes on Oahu are mostly comprised of variations on a generic design model indifferent to cultural values. The incompatibility of domestic architecture with its cultural context on Oahu is evidenced by the frequent "misuse" of domestic spaces. There are many instances of misuse of domestic space on Oahu. The garage is one of the most evident examples. Some households use the garage for everything but automobile storage. Family functions, weekend poker games, and summer lounging often take place in the garage. The car is parked on the driveway instead. This highly suggests a disconnect between design and programmatic need.

The front yard is also a domestic tradition that has been accepted as a part of the local lifestyle with very little criticism. "The essence of the [American] front yard is the unfenced lawn that serves as a public ornament," (Schroeder 2). It is often the least occupied area within the property boundaries of a single-family home, despite the fact that it accounts for a very significant amount of space.

In the 1950s, the front yard presented an open face to street. It was a reflection on the attitudes of the time where friendly extroverted gardens were for friendly extroverted people. This type of garden, however, offered no degree of privacy and neither could it be used as an 'outdoor room'. The new American gardens keep a friendly open character but also strive for privacy as well. These gardens were informal spaces of both indoor and outdoor qualities that were used for outdoor recreation and leisure. "The new American Style garden came into full flower on the West Coast about 1935." Pioneers include Frank Lloyd Wright, Maybeck, and Greene and Greene (Schroeder 20).

Dining rooms were not always a part of American home. Houses in 17th century Virginia had a multipurpose living space called the hall where family members worked, slept, socialized, cooked, and dined. It was not until the mid 18th century that the dining room emerged and eating became an increasingly elaborate and socially significant act (Wenger 149). Up until the end of the 19th century, the hosting of social ceremonies was a major focus of the American home life, and the dining room was an essential part of it. With the decline of the Victorian culture, the American household began to shed the ideas and values of formalism (Foy 68). One of the first signs if this change in domestic life was the appearance of the breakfast nook that opened off the kitchen designed for informal dining (Foy and Schlereth 27).

Today, formal dining functions are no longer a custom in the American household, particularly for Oahu residents. Even amongst wealthier households, the dining room does not hold the same sense of formality as those of the Victorian culture. Furthermore, many families opt to dine out and make very little use of the dining room. Dinner tables are often seen littered with paperwork and magazines. Many dining rooms have become makeshift home offices and study rooms. Domestic patterns of living have changed significantly since the beginning of the 20th century, but the physical environment of the single-family home has not. Additionally, the "local" domestic culture on Oahu is distinctly different from the commonly perceived "American" domestic culture on the mainland.

Cultural Differences

There are many distinctions that differentiate Hawaii's local culture from that of the "Mainland". Even as immigrants in Hawaii assimilate, their underlying cultural values continue to influence their daily lives. Group-centered behaviors are very characteristic of Hawaii's local culture (Massey 43). This is likely the result of the collective nature of Hawaii's major ethnic subcultures (Hawaiian, Japanese, Filipino, Chinese, and Korean). People from the mainland US are often thought to be highly independent and individualistic when compared with the people of Hawaii (Massey). In a study on the individualism-collectivism dimension, Hawaii was ranked the most collective state. It has been found to be a useful indicator of cultural variations in behavior, attitudes, cognitions, norms, values, goals, and family structures (Vandello).

Strong distinctions are often made between the local and mainland culture. For example, Caucasians in-migrating to Hawaii from the mainland often experience the same acculturation problems faced by non-Caucasian immigrants on the mainland (McDermott 51).

Many individualistic mainlanders have difficulty adapting to the collectivist local culture in Hawaii.

The family is often the primary social unit in Hawaii (Massey 43). A culture's emphasis on family is a key determinant of its domestic patterns of living. The extended family plays a key role in Asian and Pacific Islander ethnic groups. These groups see the family as the key social unit and place great value on family cohesion, family interdependence, and loyalty to the family (McDermott, Tseng, and Maretzki 231). Caucasian individualism stands in stark contrast to the emphasis on family associated with all of the other ethnic groups in Hawaii. Unlike other groups, Caucasians tend to "face the world as individuals" (McDermott, Tseng, and Maretzki 231). Perception of family is one of many ways that Hawaii differentiates itself culturally from the mainland United States.

The local culture of Oahu is made up of various ethnic groups that are further comprised of ethnic subgroups. Ethnic subgroups can refer to those who share a common ethnic background but speak different dialects (Massey 45). While individualists are morally obligated to treat everyone equally, collectivists are expected to treat those within the group better than those outside it (Massey 44). "It's not what you know but who you know" is a common saying in Hawaii. Hawaii residents often use connections to get business done (Massey 48). This is a strong reinforcement of the group mentality.

In Hawaii, ethnic groups retain much of their identity while contributing to a common local culture (McDermott, Tseng, and Maretzki 1). The shared local culture pervades in areas of mixed ethnic backgrounds, while racial enclaves tend to reflect the culture of the dominant ethnic group (Massey 56). It is important to understand the overriding local culture as well as the individual ethnic cultures. Also important is to understand where each ethnic group resides on the islands. The population distribution of each ethnic group differs from island to island. There are also ethnic enclaves within each island (Massey 57). Of the islands, Oahu is the most diverse.

Chapter Two: Space Syntax

This section gives an overview of the background and history of Space Syntax, its theories and techniques for analysis. The methods of spatial configuration analysis used in this study is based on Space Syntax.

Background of Space Syntax

Space Syntax was developed by Bill Hillier and Julienne Hanson in the late 1970s to early 1980s (Hillier and Hanson). *The social logic of space* was the first major publication on Space Syntax. It was first published in 1984. The Bartlett School of Architecture and Planning, University College London was involved in its conception.

Space Syntax was originally developed as a tool to help architects simulate the likely effects of their designs ("Space Syntax Laboratory Home Page"). It has developed into a tool used in a variety of research areas and design applications. It has been used in architecture, urban design, planning, transportation, and interior design. Space Syntax has also been used in fields as diverse as archaeology, information technology, urban and human geography, and anthropology . Many of its applications are computer related. At the Bartlett School, Space Syntax Laboratory is closely allied with the Virtual Reality Centre for the Built Environment ("Space Syntax Laboratory Home Page"). A consultancy practice, Space Syntax Limited, was established by University College London that utilized computer-based modeling to analyze and forecast human behavior patterns. The software used is based on the theories and techniques of Space Syntax ("Space Syntax Limited"). Space Syntax analysis is also being integrated into GIS (Jian and Claramunt).

Space Syntax encompasses a range of techniques and variations of spatial analysis. It can be applied to the analysis of settlement layouts. Settlements are a bipolar system arranged between the primary cell, or buildings, and the carrier, the world outside the settlement (Hillier and Hanson 82). Here is where a similarity can be drawn between the analysis of settlement layouts and of buildings. As settlements can be described as a system arranged between the outside world and individual buildings, buildings can be seen as systems arranged between the settlement as its carrier and individual spaces or rooms. Axial and convex maps are used in the analysis of settlement

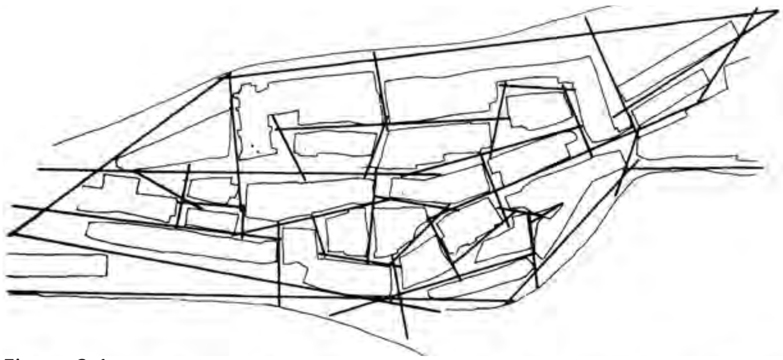


Figure 2.1
Example of an axial map (Hillier & Hanson 91).

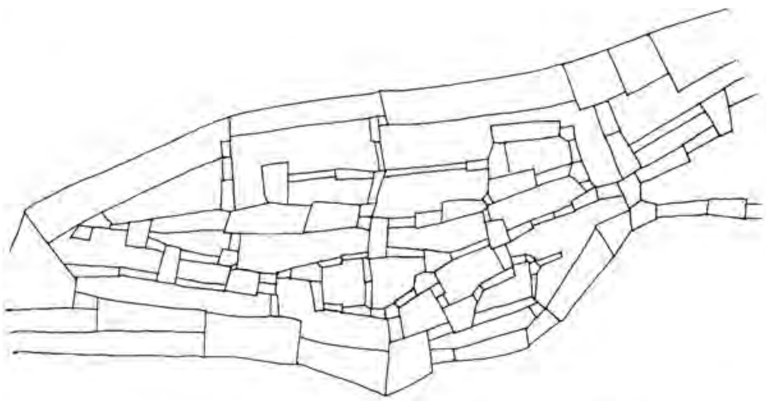


Figure 2.2
Example of a convex map (Hillier & Hanson 92).

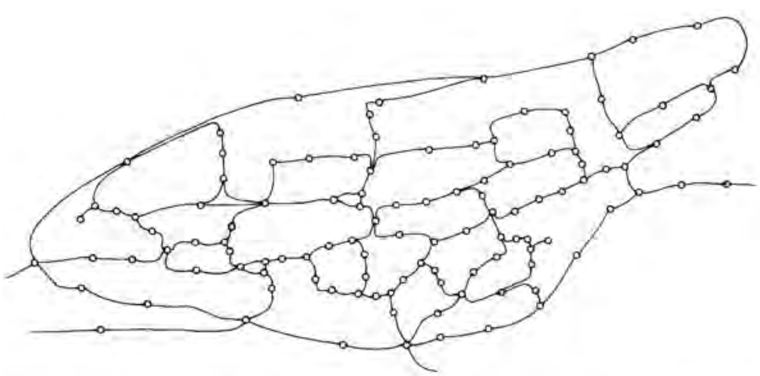


Figure 2.3
Example of a y-map (Hillier & Hanson 100).

layouts. A convex map consists of the least set of convex spaces that covers the system (Hillier and Hanson 92). A convex space is defined where no line drawn between any two points in the space goes outside of the space (Hillier and Hanson 98).

Axial maps consist of the least set of straight lines which pass through each convex space (Hillier and Hanson 92). Some of the values derived from axial maps include: axial line index, axial connectivity, ring connectivity, depth from Y values, and ringiness of the axial map (Hillier and Hanson 103-104). The y-map is a transformation of the convex map into a graph where spaces are represented by points and relations between them represented by lines. Some of the values derived from the y-map include: axial link index, axial space index, building-space index, depth from building entrances, and ringiness of the convex system (Hillier and Hanson 100-102). Justified maps are used in the analysis of settlement layouts as well as building configurations.

Spatial Patterns

Social forces are not directly related to spatial configurations but to the generators of those configurations (Hillier and Hanson 53-55). The aim is then to understand the abstract rules underlying spatial forms, rather than the spatial forms themselves (Hillier and Hanson 12). Addressing genotypes allows for the systematic comparison of a wide range of house forms, phenotypes. Identifying morphological types is a matter of identifying the combination of elementary generators that yield a particular form. In the case of this study, genotypes are identified for a sample of homes on Oahu. Social implications can be made of these spatial forms by drawing on the underlying generators of these forms. Space Syntax offers hypotheses about the relation of syntactic parameters and social variables.

The Elementary Building

The elementary building is the most basic, irreducible spatial structure of which all buildings are an elaboration of (Hanson 7). Spaces organized for social purposes can be seen as systems of boundaries and permeabilities (Hanson 5-6). Closed and open cells are made up of continuous space and spatial discontinuities. The elementary building is defined in (Hillier and Hanson) as a closed cell related by a permeability to an open cell,

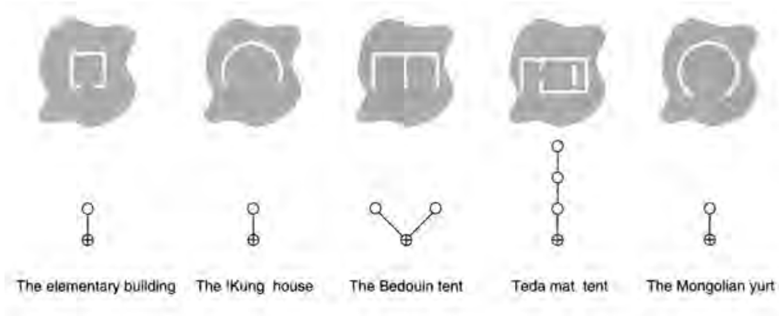


Figure 2.4
Diagrams and justified graphs of simple dwellings, including the elmentary building on the far left (Hanson 24).

the space outside. The open space may be traversed, the closed space may not be.

Sociologically, the elementary building is identified with at least one ‘inhabitant’ (Hanson 6). The inhabitant has the privileged rights of access and control of the enclosed space. The inhabitant may be a permanent occupant of the closed cell or “at least and individual whose social existence is mapped into the category of space within the cell” (Hanson 6). While the closed cell is the domain of the inhabitant, the open cell is the locus of interface between inhabitant and visitor (Hanson 6). ‘Visitors’ are a subset of ‘strangers’ who may occupy the building temporarily but do not control it. The inhabitant-visitor interface is shaped by the ordering of categories and boundaries of the building. The elementary building in its purest form is rarely found (Hanson 7). It can be represented graphically (Hanson 6-7). The bounded interior space can be represented by a circle, the unbound open space by a circle with a cross, and relations of permeability by lines. See figure 1.2 (Hanson 6).

Inside and Outside

Buildings are described as ‘primary cells’ within a settlement structure (Hillier and Hanson 143). The analysis of settlement layouts is concerned with the part of the system which lies between the boundary of the primary cell and the global structure of the settlement. The analysis of buildings is concerned with the internal structure of the primary cell. The boundary of the primary cell creates a category of space, the interior, and a form of control, the boundary itself (Hillier and Hanson 146).

The social forces that shape buildings differ from those that shape settlements in terms beyond scale (Hillier and Hanson 144). The techniques used to analyze settlements cannot simply be applied at a smaller scale to buildings. This distinction can be attributed to the boundary of the primary cell. The settlement is experienced as a continuous system created by the connecting of the spaces outside of the boundary. The spaces inside of the boundary is experienced as separate events. The set of spaces inside of the boundary creates a transpatial system. "A transpatial system is a class of spatially independent but comparable entities which have global affiliations, not by virtue of continuity and proximity, but by virtue of analogy and difference" (Hillier and Hanson 144). It is in the transpatial system that social knowledge is contained. In moving from the outside to the inside of the boundary, the focus shifts from encounter probabilities to social knowledge. The manner in which one primary cell relates to another is through a degree of congruity in the interior structuring of space.

Social solidarity can be described as spatial or transpatial (Hillier and Hanson 145). Inhabitants of a house relate to their neighbors *spatially*, occupies a location in relation to them, but also *conceptually*, interior system of spatialized categories is similar/different from those of his neighbors (Hillier and Hanson 20). Social solidarity can be interpreted as a gauge for ritual and informality (Hillier and Hanson 145). Transpatial solidarity – characterized by homogeneity, complexity, and isolation – is an indicator of formality and a strong structuring of interior space. Informality is indicated by spatial solidarity characterized by inconsistent, less elaborate interior structures with minimal control at the boundary. Transpatial solidarity is realized in the homogeneity of interior spatial structures. The more complex the spatial structure, the more exact it must be adhered to, and the stronger the transpatial solidarity. Transpatial solidarity is preserved by the segregating effect of the boundary. A transpatial solidarity is a solidarity of analogy and isolation. Spatial solidarity is realized in the continuity of the interior and exterior. Weakening of the boundary, which would undermine transpatial solidarity, is the basis for spatial solidarity. Weakening of the boundary is associated with a weaker structuring of the interior. A spatial solidarity is a solidarity of contiguity and encounter. Social solidarity also corresponds to the inhabitant-visitor interface (Hillier and Hanson 146). Transpatial solidarity tends to indicate a spatial structure that emphasizes inhabitant-inhabitant interface. An inhabitant is a transpatial entity. Spatial solidarity is an indicator of the inhabitant-visitor interface.

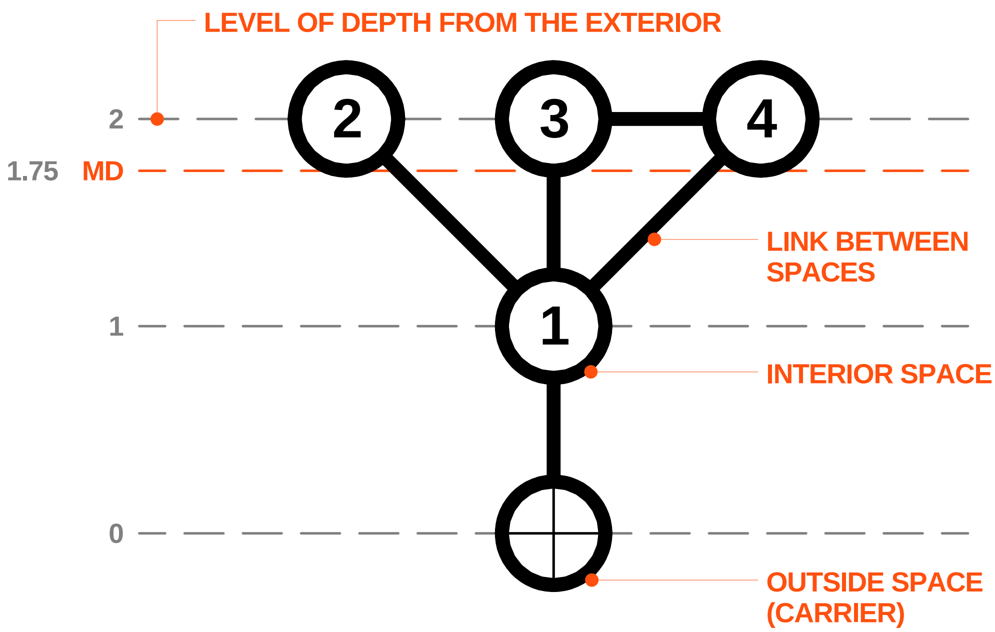


Figure 2.5
Diagram of a justified graph illustrating all its parts. Its primary components are nodes, representing individual spaces, and lines, representing the links between those spaces.

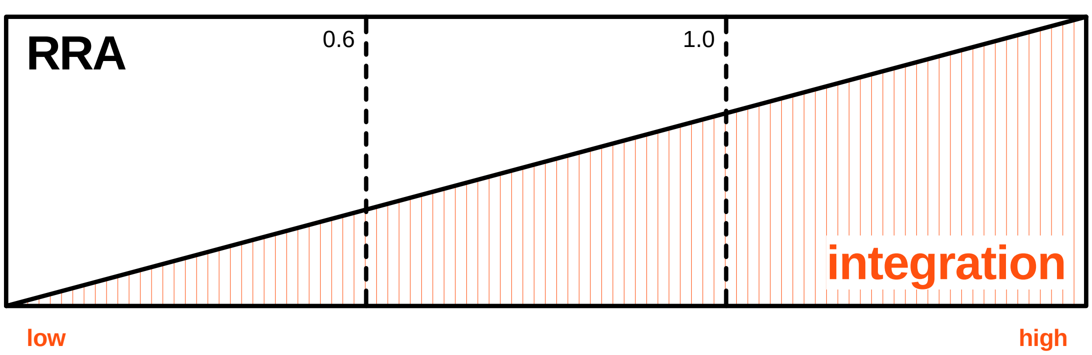


Figure 2.6
Diagram illustrating the inverse relationship of integration and real relative asymmetry (RRA). RRA values of 0.6 or lower are considered strongly segregating. RRA values of 1.0 or higher are considered strongly integrating.

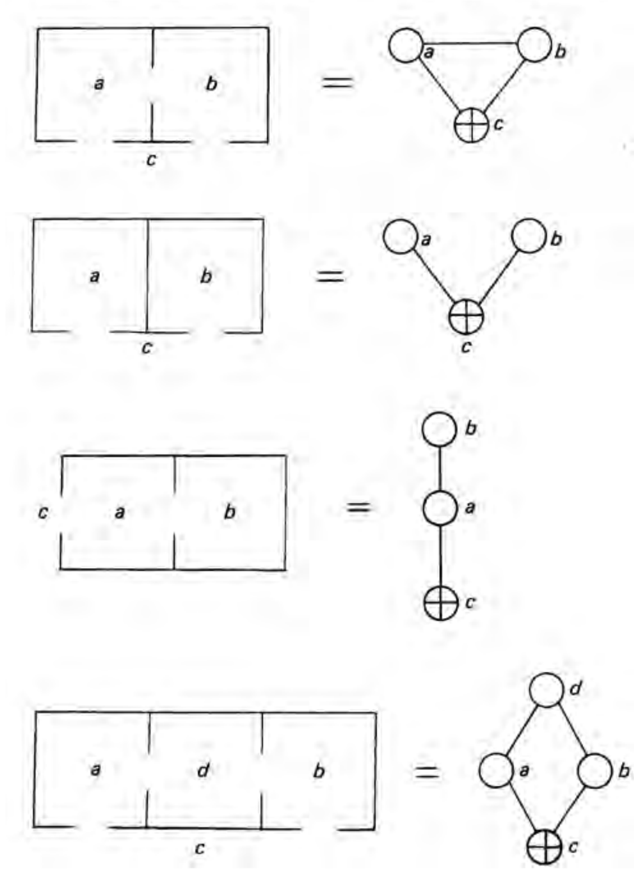


Figure 2.7
Justified graphs illustrating properties of symmetry (top two) and distributedness (bottom two) (Hillier & Hanson 148).

Justified Graphs

Social information is embedded in the way in which a system of spaces is related together to form a pattern. Configurational descriptions address space patterns rather than the localized properties of any particular space (Hanson 23). They can be used to describe the control of access and movement within a building.

Configuration, in this context, has a precise meaning (Hanson 22). "Spatial relations exist where there is any type of link between two spaces. Configuration exists when the relation which exist between two spaces are changed according to how we relate each to a third, or indeed any number of spaces," (Hanson 22). This implies that the relationship between two spaces is not isolated within a system of spaces. The experience of spaces and its transitions are cumulative.

Justified graphs are compressed configurational descriptions of space patterns. The basic components of a space pattern are elements, represented by circles, and relations, represented by lines. Justified graphs allows for the identification of elements and relations that make up a space pattern in order to compare dwellings and interpret their sociological significances (Hanson 22). Seemingly very different types of dwellings can be compared using justified graphs. Space patterns of different shapes and sizes can be analyzed and compared using justified graphs and the principles of Space Syntax.

Each space within a building is represented in a justified graph according to its depth from the outside space, also known as the carrier (Hillier and Hanson 149). The outside space is so named the carrier as it seen as a container of the building. It is

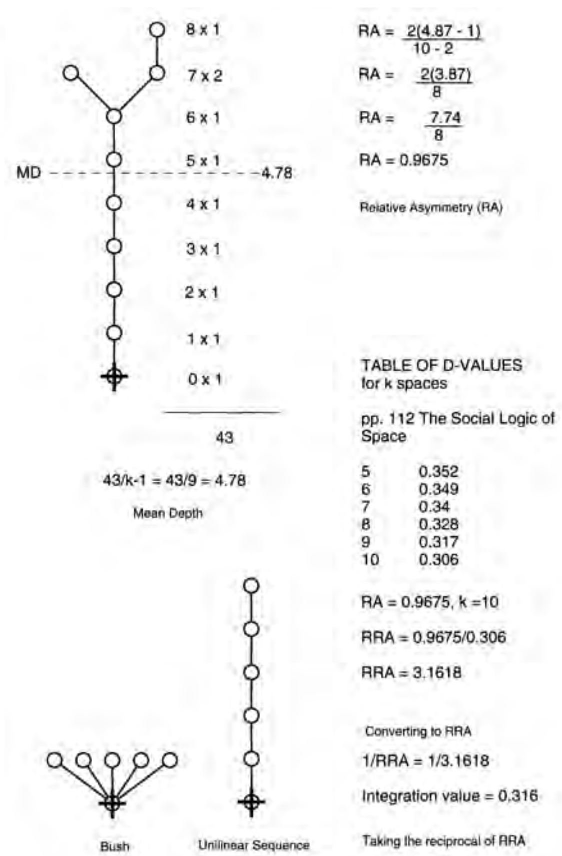


Figure 2.8
The calculation of integration values (Hanson 28).

represented as a circle with a cross. The depth value assigned to a space is the minimum number of steps required to arrive at that space from the carrier. All spaces of the same depth are aligned horizontally above the carrier, or justified. Lines in a justified graph represent direct permeabilities between spaces. The length of each line holds no significance and does not represent any actual physical distance. Justified maps make visually apparent the underlying spatial pattern of a building as well as allow for analysis procedures of quantification. Justified maps can also be created from the perspective of interior spaces. Justified maps created from different interior spaces are often dramatically different from one another and represent variations in the social information that is contained.

Symmetry and Distributedness

Symmetry is a mathematical property that can be used to describe relationships between spaces in a justified graph (Hillier and Hanson 148). Two spaces, a and b, are symmetric if A is to B as B is to A with respect to C. Neither A nor B controls permeability to each other. Two spaces, A and B are asymmetric if A is not to B as B is to A. One controls permeability to the other from a third space C. Where one space must pass through a second to arrive at a third, the first and second spaces are asymmetric.

Distributedness is used to describe relations of control. It measures the existence of alternative routes between points in a justified graph (Hillier and Hanson 148). Two spaces, A and B, are distributed if there is more than one route from A to B, including one passing through a third space C. Two spaces, A and B, are non-distributed if there is a space through C through which all paths between A and B must pass. A space is distributed if there is more than one locus of control with respect to another.

Relative asymmetry (RA) is used to quantify the symmetry-asymmetry dimension of the configuration model, and *relative ringiness* (RR) is used to quantify the distributed-nondistributed dimension (Hillier and Hanson 153). Relative asymmetry is associated with relations of depth in a configuration model. “Spaces can only be deep from other spaces if it is necessary to pass through intervening spaces to arrive at them,” (Hillier and Hanson 108). Relative asymmetry measures the depth of the system from particular spaces in a configuration model in reference to the theoretical maximum and minimum depth. Relative asymmetry (RA) for a space is determined by the two variables: mean depth of the configuration model (MD) and the number of spaces in the configuration model (K).

RA = [2 (MD – 1)] / K – 2

Mean depth (MD) for a space is calculated by assigning a depth value for every other space in the configuration model according to the number of steps from the original space. These depth values are then summed and divided by the number of spaces in the system minus one, the original space (Hillier and Hanson 108). Relative asymmetry will be given as a value between 0 and 1. Spaces that tend to integrate the system will have lower RA values. The configuration model of these spaces tend to be shallower. Higher RA values indicate spaces that are more segregated from the system. RA values are also referred to as integration values.

Relative ringiness is associated with the number of links in the configuration model (Hillier and Hanson 154). As the name suggests, relative ringiness is a measure of the number of rings in a configuration model. Rings are formed in a configuration model where three or more spaces are connected along a continuous closed path. Distributedness can be defined as a relation with more than one locus of control. Increasing the number of rings in a system will increase the distributedness of the configuration model as a whole and of the spaces along the rings. The least number of links required to connect a system is K – 1. Any increase in the number of links, represented by lines on a justified graph, will form rings. The relative ringiness of a space is given by the number of distinct rings over the maximum possible planar rings of the configuration model.

RR = [E – (N – 1)] / [2N – 5]

The number of distinct rings is given by E – (N – 1). The maximum possible planar rings in a configuration model is given by 2N – 5. E is the mean distance of the space from each ring in the configuration model. The distance of a space to a ring is the number of steps taken to arrive at the nearest space on the ring. A value of 1 is added to this number to exclude zeros in the calculation. N is the total number of spaces in the system.

Control values (E) can be used in place of relative ringiness to measure the distributed-nondistributed dimension (Hillier and Hanson 109). It is a much simpler method used to measure control for individual spaces. Unlike relative asymmetry and relative ringiness values, however, control values are local measures. Where relative asymmetry and relative ringiness takes into account the relations of a space to every other space, control values only account for the relation between a space and its immediate neighbors. In calculating control values, each space has a certain number N of immediate neighbors. Each space conveys to each of its immediate neighbors a degree of control equal to 1/N. Each space partitions one unit of value among its neighbors and receives a certain amount in return. The total value received by a space is its control value (E).

Integration Values

Social information is transmitted in buildings through their interior structures. It can be derived from variations in the basic syntactic parameters – integration and control – and more so from the variations in the syntactic parameters which appear when the complex is viewed from the perspective of its various constituent spaces (Hillier and Hanson 154). The genotype of a settlement is primarily defined in terms of syntactic generators governing encounter probabilities. Relative ringiness, an indicator of control, is more informative of settlement genotypes. The genotype of a building is primarily defined in terms of the relationship between individual spaces and their relationship to the complex as a whole. Relative asymmetry, an indicator of integration, is more informative of building genotypes. Integration is one of the fundamental ways in which houses convey culture through their configurations (Hanson 32). "Integration is the key by which we can understand the social content of architecture and show how buildings and places function at a collective level" (Hanson 1).

Integration is measured by relative asymmetry (Hillier and Hanson 109). A low RA value indicates a high degree of integration. RA values are clear expressions of integration, ranging from 0 being most integrated to 1 being most segregated. They are useful in describing the degree of integration for a configuration model and in comparing spaces within the same system. However, RA values do not account for differences in size when comparing two or more systems (Hillier and Hanson 109-113). In order to give accurate accounts of integration when comparing systems that differ considerably in size, RA values need to be adjusted. Real relative asymmetry (RRA) is the adjusted value that gives a true account of integration when comparing systems of significantly different sizes. To arrive at the RRA for a particular space in a configuration model, its RA value is compared with the RA value for the root, or the space at the bottom of a justified map, of a diamond-shaped pattern containing the same number of spaces as the configuration model.

RRA = RA / D

The RA value for the root of a diamond-shaped pattern containing K points is given by D in the equation. Refer to (Hillier and Hanson 112) for these values. RRA values do not fall properly between 0 and 1 as do RA values. RRA values below 0.6 are considered strong integration values. RRA values above 1 are considered strong segregation values. The mean RRA value, taken from all points in a system, is a general measure of integration for the system as a whole (Hillier and Hanson 109). This is a useful figure for general comparison of integration for different configuration models.

A few basic configuration models can be examined to see how patterns affect syntactic parameters. There can be no more depth from a point in a configuration than a sequence, nor less than a bush. A tree has the minimum number of connections to join a configuration. Rings add additional connections, up to a theoretical maximum where every space is connected to every other.

For ring-less configurations, bushy patterns have the lowest mean RRA values. Five bushy configurations are illustrated with their justified graphs alongside building geometries they can be made to represent. See Figure 2.9. Mean RA and RRA values have also been calculated for these configuration models. These five configurations contain 8, 9, 10, 11, and 12 spaces and can illustrate the changes in integration values as additional spaces are attached to a configuration. For bushy configuration 1, the mean RRA value is calculated at 0.701. According to (Hillier and Hanson), this is not a strong integration value. As additional spaces are added to the configuration, the RRA value decreases by decreasing intervals. From a mean RRA value of 0.701 for a bushy configuration of 8 spaces, the mean RRA value is decreased to 0.558 for a bushy configuration of 12 spaces. The change in RRA value also decreases from 0.047 in the first addition to 0.027 for the last addition of space. Adding spaces to the root of a bushy configuration will decrease the mean RRA, or strengthen integration. This effect, however, is lessened as the total number of spaces increase.

In a linear configuration, spaces are arranged in a sequential linear pattern where each space is deeper than the last from the carrier. This configuration yields the highest mean RRA value for a continuous space pattern. Five linear configuration patterns are illustrated with 8, 9, 10, 11, and 12 spaces. See Figure 2.10. Unlike the bushy configuration, linear patterns become more segregated as spaces are added to the system. The first linear configuration of 8 spaces has a mean RRA value of 2.103, which is already 3 times that of a bushy configuration of the same size. As spaces are added, the mean RRA value increases. Interestingly, the mean RA value remains at 0.667 as spaces are added to the system. The linear configuration is a good illustration of the difference between RA and RRA values. The linear configuration is the least integrated configuration possible. As the spaces in a linear configuration increases, the mean RRA value increases.

A combination of the bushy and linear patterns, the tree configuration is a common building configuration model and represents the middle range of integration. Five tree-like configurations are illustrated with their justified graphs alongside building geometries they can be made to represent. Unlike the previous two sets of examples, however, these configurations all contain 8 spaces. See Figure 2.11. These examples illustrate the transition from a bushy configuration to a linear one. The transition is apparent in the justified graphs as well as the calculated integration values. For systems 8 spaces in size, the mean RRA is calculated at 0.701 for a bushy configuration and 2.103 for a linear configuration. Unsurprisingly, the range of mean integration values given for the tree-like configurations fall within these values. The mean RRA values for this set of examples range from 0.701 to 1.702. The first tree-like configuration is essentially a bushy configuration taken one step away from the carrier. The configurations that follow begin to transition into a linear configuration by transferring spaces from the bushy part of the pattern to the linear part. The mean RRA values increase as the configurations become more segregated. The intervals of change are much more significant than in the previous two sets of examples. This is attributed to the process by which the configurations are changing from one to the next. The removal of spaces from the bushy pattern and the addition of spaces to the linear patter are both processes that increase segregation. Where only one of these were responsible for the changes in the previous two sets of examples, both are involved in the transition from a bushy pattern to a linear one.

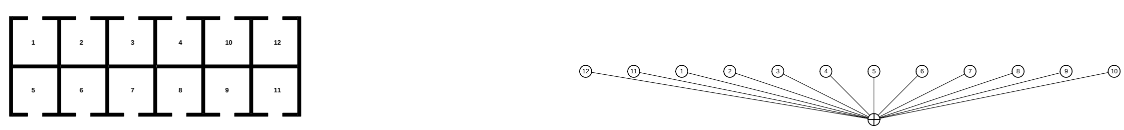
The last set of examples discussed in this section involves ringy configuration models. They are meant to illustrate the effects of rings on integration values. The justified graphs for ringy complexes tend to be more complex. The addition of rings to a system invariably increases the ringiness of the system, but less apparent is the effect that it has on integration values. Five configurations are illustrated here, each containing one more distinctive ring than the last. See Figure 2.12. The rings in the justified graphs are created by creating openings between partitioned spaces. The calculations show a considerable increase in integration as rings are added to the system. The intervals of change are less than what is seen in the tree-like examples but greater than what is seen in the bushy and linear examples.

mean RA = 0.222
mean RRA = 0.701

mean RA = 0.200
mean RRA = 0.654

mean RA = 0.182
mean RRA = 0.616

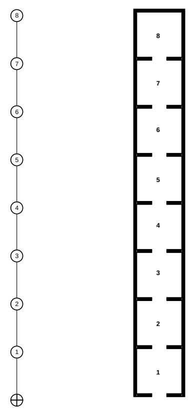
mean RA = 0.167
mean RRA = 0.585



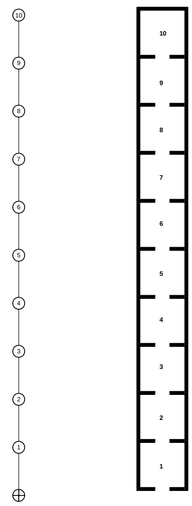
mean RA = 0.154
mean RRA = 0.558

Figure 2.9
Bushy configuration model, building geometries and justified graphs.

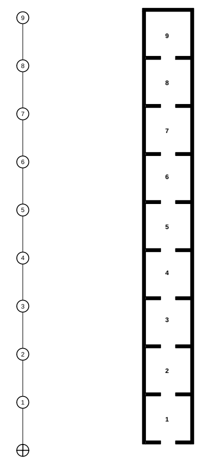
mean RA = 0.667
mean RRA = 2.103



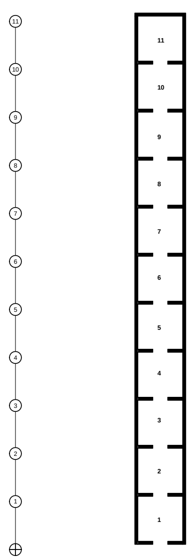
mean RA = 0.667
mean RRA = 2.260



mean RA = 0.667
mean RRA = 2.179



mean RA = 0.667
mean RRA = 2.339



mean RA = 0.667
mean RRA = 2.415

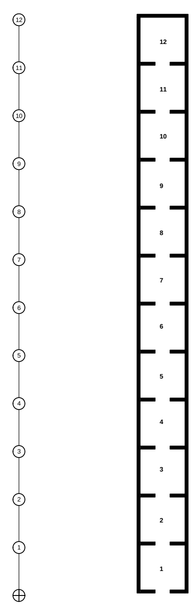
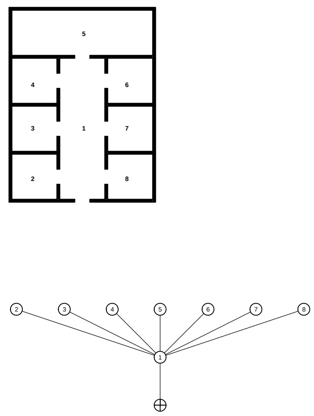
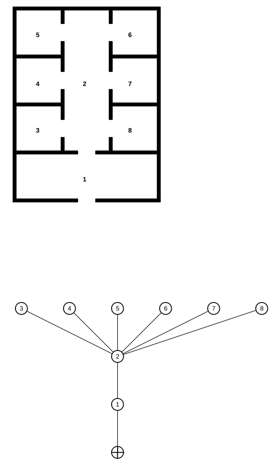


Figure 2.10
Linear configuration model, building geometries and justified graphs.

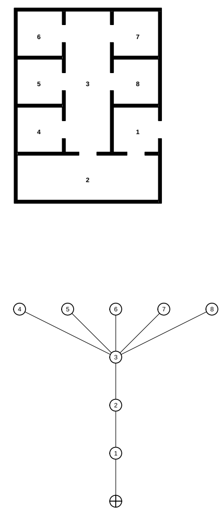
mean RA = 0.222
mean RRA = 0.701



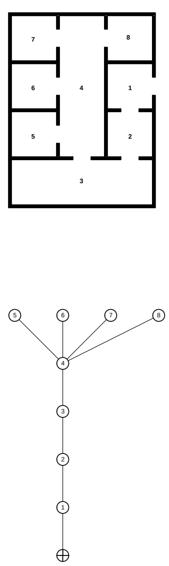
mean RA = 0.103
mean RRA = 0.325



mean RA = 0.349
mean RRA = 1.102



mean RA = 0.444
mean RRA = 1.402



mean RA = 0.540
mean RRA = 1.702

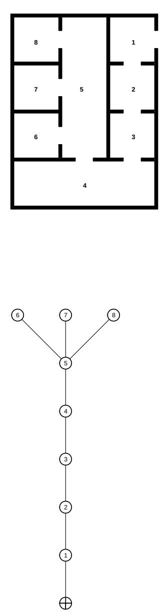


Figure 2.11
Tree-like configuration model, building geometries and justified graphs.

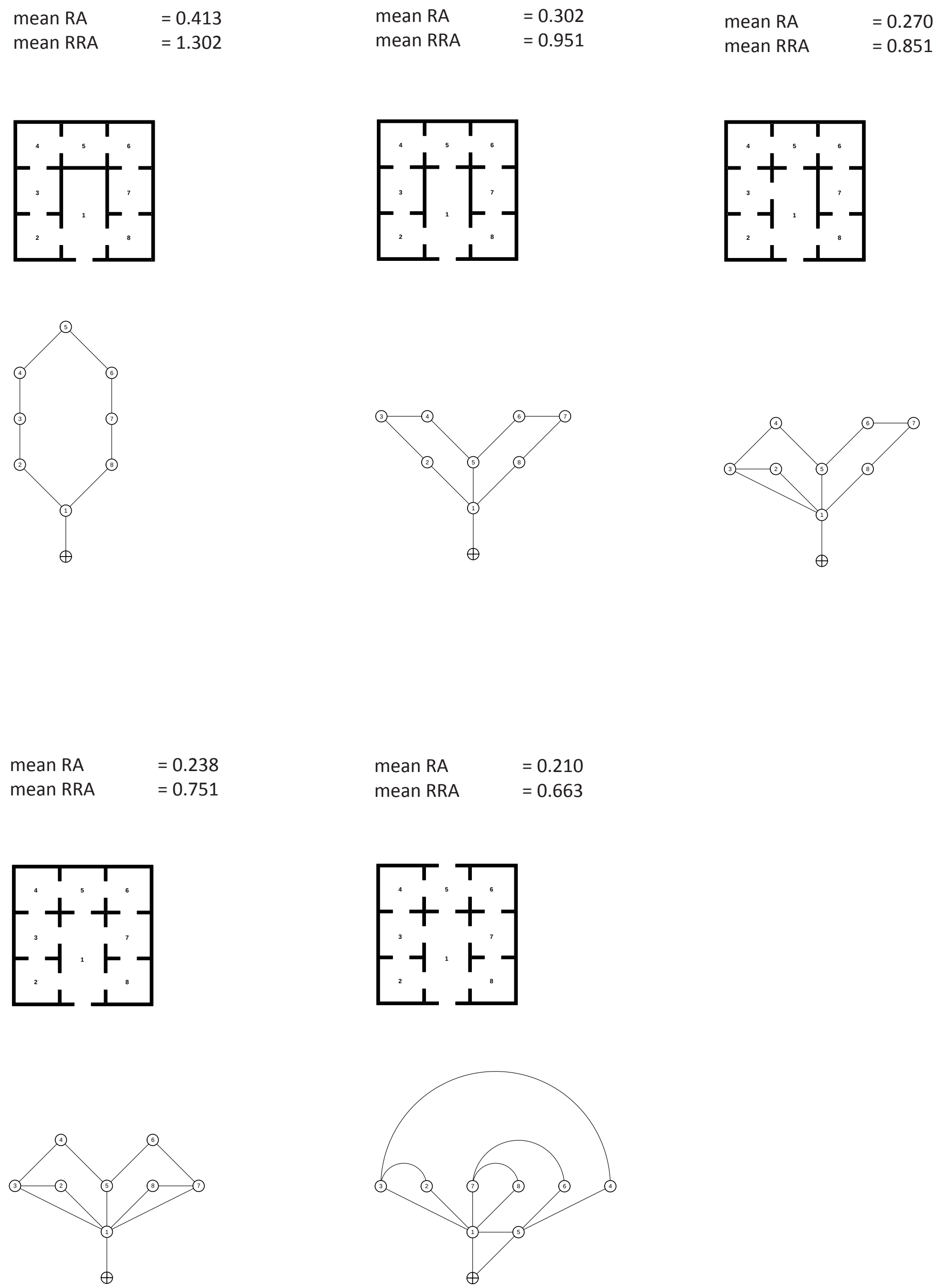


Figure 2.12
Ringy configuration model, building geometries and justified graphs.

Chapter Three: Analysis of Single-Family Homes on Oahu.

Spatial configuration analysis is conducted on a sample of single-family homes on Oahu using principles and techniques drawn from Space Syntax. An objective is to identify recurring syntactic generators that may point to the definition of a genotype for domestic environments on Oahu. More importantly, these syntactic generators reveal the nature of disconnect between the physical domestic environment and local culture on Oahu. Syntactic generators refer to abstract rules underlying spatial forms (Hillier and Hanson 12). The breakdown of each home into its justified graph and the syntactic parameters that are drawn from it reveal spatial relations that a are not apparent otherwise.

A sample of 10 homes are presented in this study. The homes were initially selected from an online real estate listing for Oahu. The homes posted for sale were categorized by area, size, and age – necessarily simplifying the selection process. The sample selected was kept as homogenous as possible. Homes were selected from different areas of the island. Initially, the sample consisted of 40 homes. It was reduced for the sake of this study. The homes that remained in the sample were representative of the original larger sample. Addresses and tax map keys (TMK) were extracted from the real estate website and used to obtain floor plans from City and County of Honolulu Department of Planning and Permitting (DPP). Based on these floor plans, justified graphs were created for the sample and syntactic parameters calculated.

On the surface, the sample of homes seems very diverse. They range in size from 3-6 bedrooms, 900 SF TO 2200 SF. Their justified graphs also seem to vary significantly. However, a closer look will reveal a number of visual similarities in the spatial pattern. All but one configuration model contains at least one ring. Along the ring are the main gathering spaces of the house – living room, kitchen, dining room, etc. The rings are usually located close to the carrier, meaning that they are shallow in depth. Characteristic of all configuration models is a node in the justified graph that branches off to four or more adjacent nodes. These are often circulation spaces. One way to describe the configuration model of the sample in general terms is a tree-like configuration with shallow rings.

The configuration changes dramatically when taken from the perspective of different rooms in the house. The justified graphs taken from every space in the configuration is shown for the Kuea Home. See Figure 3.11 and Figure 3.12. It is visually apparent that each space in the house is configurationally different. The depth and width of the graph changes dramatically. Calculation of its integration values show that they are indeed functionally different as well.

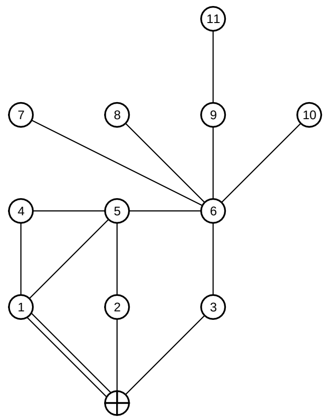
Integration values can have different implications depending on context. It can be linked to privacy, circulation, visual connection, and use. Depth and rings are the fundamental properties of architectural space configuration. The significance and meaning of integration values can differ from one configuration to the next. Integration values can also carry with it varying implications in different cultural contexts.

The integration value of an individual space is an indicator of its relationship to the other spaces in that configuration. It is measured in terms of real relative asymmetry, RRA. Integration value is an indicator of how busy or quiet a space may be (Hanson 1). This is a general quality of space that can further imply specific spatial properties. The integration value of the outside space carries further implications. It is an indicator of the interior-exterior relationship. An outdoor space with a high integration value may indicate that the exterior of the house is used frequently. An outdoor space with a high integration value may also be an indicator that the inhabitant-visitor interface is valued. It is an indicator of privacy. The integration value of the outside space is largely affected by the number of interior-exterior links. Mean integration value is the measure of integration of the configuration as a whole. This value is useful as a general description of integration for a building and in comparing the properties of integration of two or more buildings.

Mean Integration values of the sample presents an informative overview of the underlying structures of the average home on Oahu. The mean integration values of single-family homes on Oahu fall in the middle range (average Mean RRA = 1.163; Mean RRA ranges 0.845 – 1.402). They fall in the range of values of tree–like configurations. The justified graphs of the sample are predominantly tree–like as well. The majority of homes are not configured to be distinctly private or public. This reaffirms the assumption that the majority of homes on Oahu is based on generic models.

Tree–like configurations, characteristic of the sample, are relatively deep. Majority of spaces are deep from the outside space. Where a space leads to two or more adjacent spaces is typically a hallway. Symmetry is apparent in the configuration graph. In comparison to ringy configurations, tree-like configurations are generally simpler. The simpler tree-like configuration again reflects the generic approach to design of domestic space for Oahu homes. This suggests that the programming of domestic environments on Oahu does not give enough critical consideration for culture, given the richness of culture on Oahu.

Figure 3.1
92-1311 Hookeha Street
TMK: 192025071
Area: 1800 SF



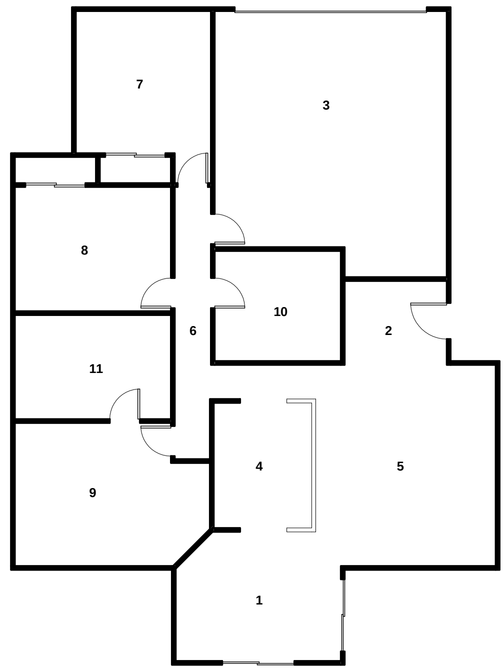


Table 3.1
Integration Values for Hookeha House.

	SPACE	NO.	MD (MEAN DEPTH)	K (NO. OF SPACES)	RA (RELATIVE ASSYMETRY)	D-VALUE (HILLIER & HANSON 112)	RRA	Integration Value
8	**HOOKEHA**							
	OUTSIDE SPACE	⊕	2.273	12.000	0.255	0.285	0.893	1.119
	DINING	1	2.273	12.000	0.255	0.285	0.893	1.119
	ENTRY	2	2.273	12.000	0.255	0.285	0.893	1.119
	GARAGE	3	2.000	12.000	0.200	0.285	0.702	1.425
	KITCHEN	4	2.455	12.000	0.291	0.285	1.021	0.979
	LIVING ROOM	5	1.727	12.000	0.145	0.285	0.510	1.960
	HALLWAY	6	1.455	12.000	0.091	0.285	0.319	3.132
	BEDROOM 1	7	2.364	12.000	0.273	0.285	0.957	1.045
	BEDROOM 2	8	2.364	12.000	0.273	0.285	0.957	1.045
	BEDROOM 3	9	2.182	12.000	0.236	0.285	0.829	1.206
	BATHROOM 1	10	2.364	12.000	0.273	0.285	0.957	1.045
	BATHROOM 2	11	2.727	12.000	0.345	0.285	1.212	0.825
	MEAN INTEGRATION				**0.241**		**0.845**	

Figure 3.2
91-116 Makaaloa Street
TMK: 191062116
Area: 2200 SF

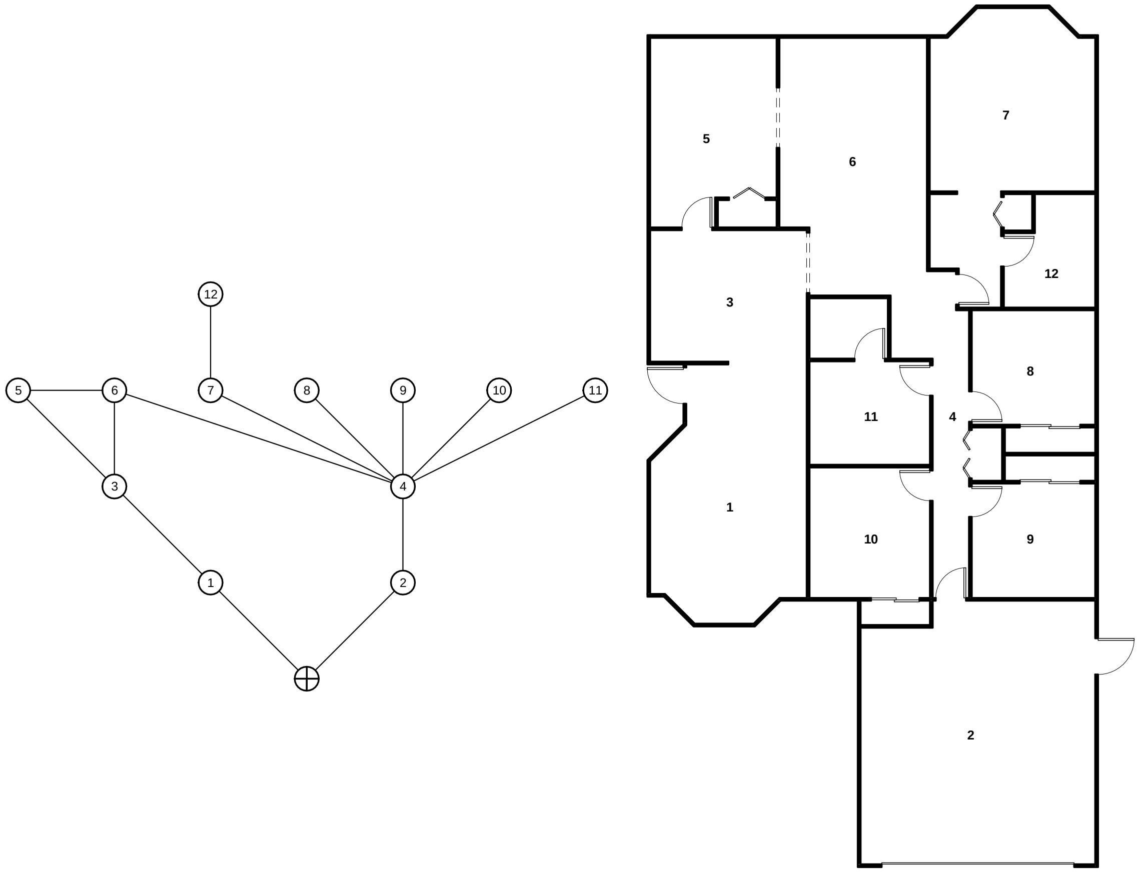


Table 3.2
Integration Values for Makaaloa House.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
7	**MAKAALOA**							
	OUTSIDE SPACE	⊕	2.583	13.000	0.288	0.276	1.043	0.959
	LIVING ROOM	1	3.000	13.000	0.364	0.276	1.318	0.759
	GARAGE	2	2.083	13.000	0.197	0.276	0.713	1.402
	DINING ROOM	3	2.583	13.000	0.288	0.276	1.043	0.959
	HALLWAY	4	1.500	13.000	0.091	0.276	0.329	3.036
	KITCHEN	5	2.333	13.000	0.242	0.276	0.878	1.139
	FAMILY ROOM	6	1.917	13.000	0.167	0.276	0.604	1.655
	BEDROOM 1	7	2.250	13.000	0.227	0.276	0.823	1.214
	BEDROOM 2	8	2.417	13.000	0.258	0.276	0.933	1.071
	BEDROOM 3	9	2.417	13.000	0.258	0.276	0.933	1.071
	BEDROOM 4	10	2.417	13.000	0.258	0.276	0.933	1.071
	BATHROOM 1	11	2.417	13.000	0.258	0.276	0.933	1.071
	BATHROOM 2	12	3.167	13.000	0.394	0.276	1.428	0.701
					0.253		**0.916**	

Figure 3.3
84-1005 Hana Street
TMK: 184013015
Area: 2600 SF

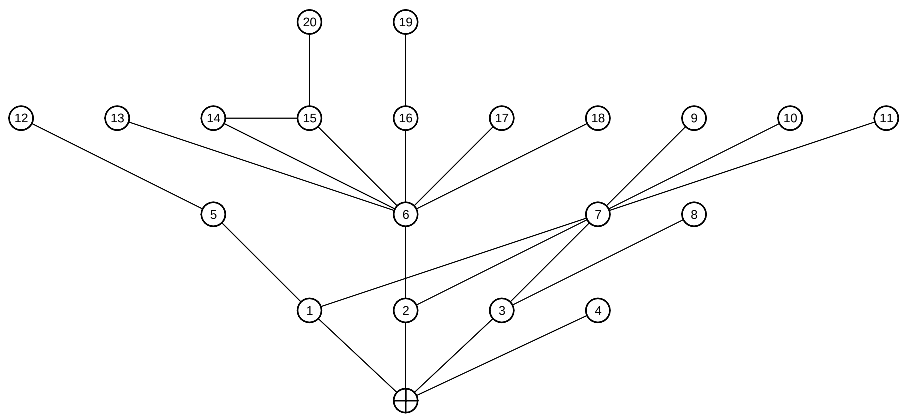


Table 3.3
Integration Values for Makaaloa House.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
4	**HANA**							
	OUTSIDE SPACE	⊕	2.500	21.000	0.158	0.220	0.718	1.393
	LIVING ROOM 1	1	2.850	21.000	0.195	0.220	0.885	1.130
	STAIRCASE	2	2.150	21.000	0.121	0.220	0.550	1.817
	CARPORT 1	3	2.950	21.000	0.205	0.220	0.933	1.072
	CARPORT 2	4	3.450	21.000	0.258	0.220	1.172	0.853
	FAMILY ROOM	5	3.700	21.000	0.284	0.220	1.292	0.774
	HALLWAY 1	6	2.300	21.000	0.137	0.220	0.622	1.608
	HALLWAY 2	7	2.300	21.000	0.137	0.220	0.622	1.608
	BATHROOM 1	8	3.900	21.000	0.305	0.220	1.388	0.721
	BEDROOM 1	9	3.250	21.000	0.237	0.220	1.077	0.929
	BEDROOM 2	10	3.250	21.000	0.237	0.220	1.077	0.929
	BATHROOM 2	11	3.250	21.000	0.237	0.220	1.077	0.929
	BATHROOM 3	12	4.650	21.000	0.384	0.220	1.746	0.573
	BATHROOM 4	13	3.250	21.000	0.237	0.220	1.077	0.929
	LIVING ROOM 2	14	3.150	21.000	0.226	0.220	1.029	0.972
	KITCHEN	15	3.100	21.000	0.221	0.220	1.005	0.995
	BEDROOM 3	16	3.150	21.000	0.226	0.220	1.029	0.972
	BEDROOM 4	17	3.250	21.000	0.237	0.220	1.077	0.929
	BEDROOM 5	18	3.250	21.000	0.237	0.220	1.077	0.929
	BATHROOM 5	19	4.100	21.000	0.326	0.220	1.483	0.674
	PATIO	20	4.050	21.000	0.321	0.220	1.459	0.685
	MEAN INTEGRATION				**0.235**		**1.066**	

Figure 3.4
56-254 Leleuli Street
TMK: 156009051
Area: 2000 SF

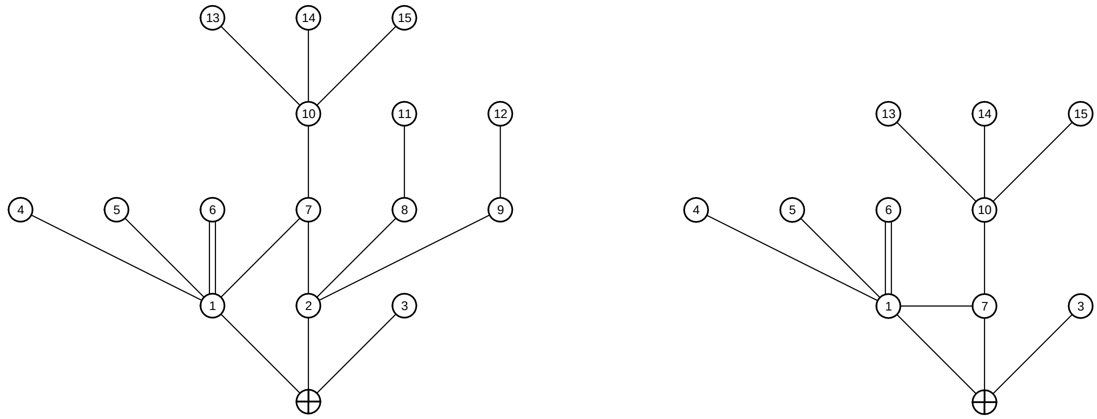


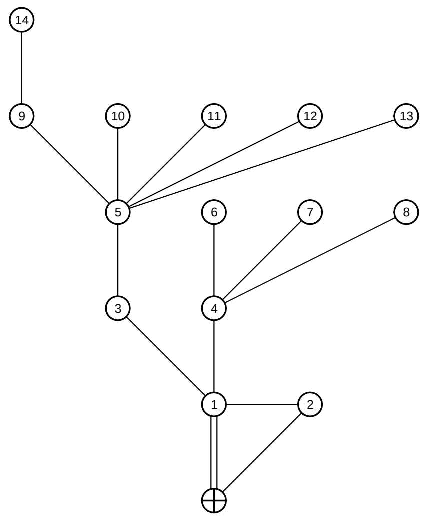
Table 3.4
Integration Values for Leleuli House.

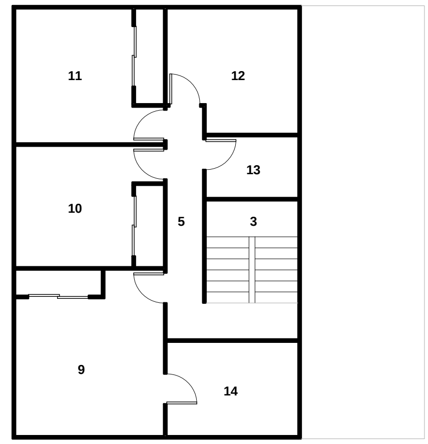
	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
10	**LELEULI**							
	OUTSIDE SPACE	⊕	2.400	16.000	0.200	0.251	0.797	1.255
	HALLWAY 1	1	2.267	16.000	0.181	0.251	0.721	1.387
	ENTRY	2	2.133	16.000	0.162	0.251	0.645	1.551
	LAUNDRY	3	3.333	16.000	0.333	0.251	1.328	0.753
	BATHROOM 1	4	3.200	16.000	0.314	0.251	1.252	0.799
	BEDROOM 1	5	3.200	16.000	0.314	0.251	1.252	0.799
	KITCHEN	6	3.200	16.000	0.314	0.251	1.252	0.799
	LIVING ROOM	7	2.000	16.000	0.143	0.251	0.569	1.757
	STAIRWAY	8	2.933	16.000	0.276	0.251	1.100	0.909
	BEDROOM 2	9	2.933	16.000	0.276	0.251	1.100	0.909
	HALLWAY 2	10	2.533	16.000	0.219	0.251	0.873	1.146
	FAMILY ROOM	11	3.867	16.000	0.410	0.251	1.632	0.613
	BATHROOM 2	12	3.867	16.000	0.410	0.251	1.632	0.613
	BEDROOM 3	13	3.467	16.000	0.352	0.251	1.404	0.712
	BATHROOM 3	14	3.467	16.000	0.352	0.251	1.404	0.712
	BEDROOM 4	15	3.467	16.000	0.352	0.251	1.404	0.712
	MEAN INTEGRATION				**0.288**		**1.148**	

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
10b	**LELEULI**							
	Without carrier							
	HALLWAY 1	1	2.385	14.000	0.231	0.267	0.865	1.157
	ENTRY	2	2.231	14.000	0.205	0.267	0.768	1.301
	LAUNDRY	3						
	BATHROOM 1	4	2.308	14.000	0.218	0.267	0.816	1.225
	BEDROOM 1	5	2.308	14.000	0.218	0.267	0.816	1.225
	KITCHEN	6	2.308	14.000	0.218	0.267	0.816	1.225
	LIVING ROOM	7	1.923	14.000	0.154	0.267	0.576	1.736
	STAIRWAY	8	3.000	14.000	0.333	0.267	1.248	0.801
	BEDROOM 2	9	3.000	14.000	0.333	0.267	1.248	0.801
	HALLWAY 2	10	2.385	14.000	0.231	0.267	0.865	1.157
	FAMILY ROOM	11	3.923	14.000	0.487	0.267	1.825	0.548
	BATHROOM 2	12	3.923	14.000	0.487	0.267	1.825	0.548
	BEDROOM 3	13	3.308	14.000	0.385	0.267	1.441	0.694
	BATHROOM 3	14	3.308	14.000	0.385	0.267	1.441	0.694
	BEDROOM 4	15	3.308	14.000	0.385	0.267	1.441	0.694
	MEAN INTEGRATION				**0.305**		**1.142**	

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
10c	**LELEULI-ORIGINAL**							
	OUTSIDE SPACE	⊕	2.000	11.000	0.222	0.295	0.753	1.328
	HALLWAY 1	1	1.800	11.000	0.178	0.295	0.603	1.659
	LAUNDRY	3	2.900	11.000	0.422	0.295	1.431	0.699
	BATHROOM 1	4	2.700	11.000	0.378	0.295	1.281	0.781
	BEDROOM 1	5	2.700	11.000	0.378	0.295	1.281	0.781
	KITCHEN	6	2.700	11.000	0.378	0.295	1.281	0.781
	LIVING ROOM	7	1.600	11.000	0.133	0.295	0.452	2.213
	HALLWAY 2	10	2.200	11.000	0.267	0.295	0.904	1.106
	BEDROOM 3	13	2.800	11.000	0.400	0.295	1.356	0.738
	BATHROOM 3	14	2.800	11.000	0.400	0.295	1.356	0.738
	BEDROOM 4	15	2.800	11.000	0.400	0.295	1.356	0.738
					0.323		**1.096**	

Figure 3.5
91-648 Laukona Street
TMK: 191034069
Area: 1650 SF





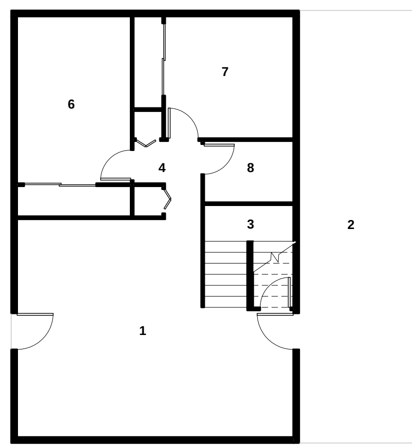


Table 3.5
Integration Values for Laukona House.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
5	**LAUKONA**							
	OUTSIDE SPACE	⊕	3.071	15.000	0.319	0.259	1.230	0.813
	LIVING ROOM / KITCHEN	1	2.214	15.000	0.187	0.259	0.721	1.387
	PATIO	2	3.071	15.000	0.319	0.259	1.230	0.813
	STAIRWAY	3	2.143	15.000	0.176	0.259	0.679	1.473
	HALLWAY 1	4	2.714	15.000	0.264	0.259	1.018	0.982
	HALLWAY 2	5	2.214	15.000	0.187	0.259	0.721	1.387
	BEDROOM 1	6	3.643	15.000	0.407	0.259	1.570	0.637
	BEDROOM 2	7	3.643	15.000	0.407	0.259	1.570	0.637
	BATHROOM 1	8	3.643	15.000	0.407	0.259	1.570	0.637
	BEDROOM 3	9	3.000	15.000	0.308	0.259	1.188	0.842
	BEDROOM 4	10	3.143	15.000	0.330	0.259	1.273	0.786
	BEDROOM 5	11	3.143	15.000	0.330	0.259	1.273	0.786
	BEDROOM 6	12	3.143	15.000	0.330	0.259	1.273	0.786
	BATHROOM 2	13	3.143	15.000	0.330	0.259	1.273	0.786
	BATHROOM 3	14	3.930	15.000	0.451	0.259	1.740	0.575
	MEAN INTEGRATION				**0.316**		**1.222**	

Figure 3.6
55-482 Palekana Street
TMK: 155013098
Area: 1700 SF

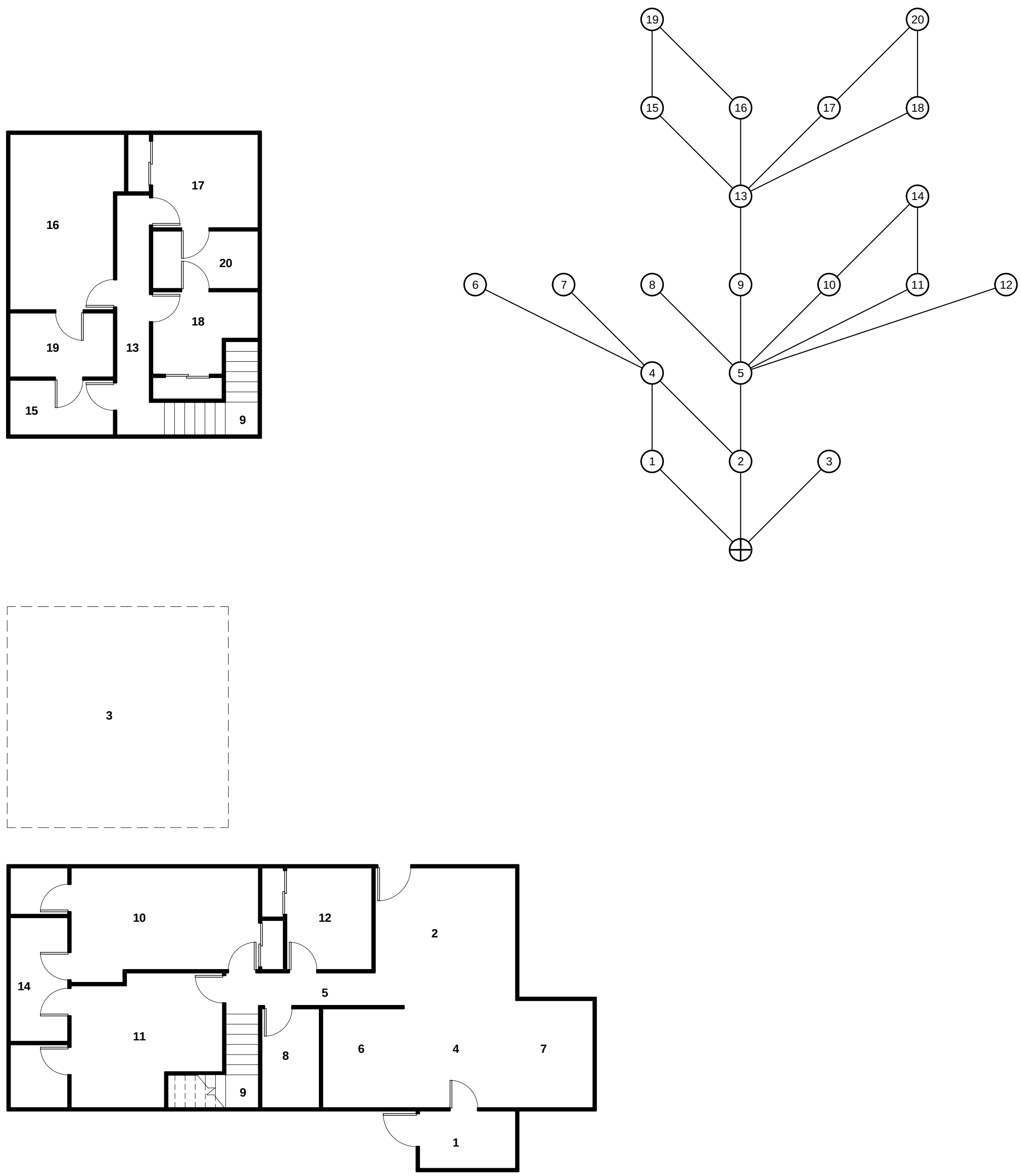


Table 3.6
Integration Values for Palekana House.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
9	**PALEKANA**							
	OUTSIDE SPACE	⊕	3.400	21.000	0.253	0.220	1.148	0.871
	UTILITY	1	4.050	21.000	0.321	0.220	1.459	0.685
	LIVING ROOM	2	2.650	21.000	0.174	0.220	0.789	1.267
	GARAGE	3	4.350	21.000	0.353	0.220	1.603	0.624
	DINING	4	3.300	21.000	0.242	0.220	1.100	0.909
	HALLWAY 1	5	2.300	21.000	0.137	0.220	0.622	1.608
	KITCHEN	6	4.250	21.000	0.342	0.220	1.555	0.643
	FAMILY ROOM	7	4.250	21.000	0.342	0.220	1.555	0.643
	BATHROOM 1	8	3.250	21.000	0.237	0.220	1.077	0.929
	STAIRWAY	9	2.550	21.000	0.163	0.220	0.742	1.348
	BEDROOM 1	10	3.150	21.000	0.226	0.220	1.029	0.972
	BEDROOM 2	11	3.150	21.000	0.226	0.220	1.029	0.972
	BEDROOM 3	12	3.250	21.000	0.237	0.220	1.077	0.929
	HALLWAY 2	13	2.900	21.000	0.200	0.220	0.909	1.100
	BATHROOM 2	14	4.000	21.000	0.316	0.220	1.435	0.697
	BATHROOM 3	15	3.750	21.000	0.289	0.220	1.316	0.760
	BEDROOM 4	16	3.750	21.000	0.289	0.220	1.316	0.760
	BEDROOM 5	17	3.750	21.000	0.289	0.220	1.316	0.760
	BEDROOM 6	18	3.750	21.000	0.289	0.220	1.316	0.760
	CLOSET	19	4.600	21.000	0.379	0.220	1.722	0.581
	BATHROOM 4	20	4.600	21.000	0.379	0.220	1.722	0.581
	MEAN INTEGRATION				**0.271**		**1.230**	

Figure 3.7
84-570 Nukea Street
TMK: 184028050
Area: 900 SF

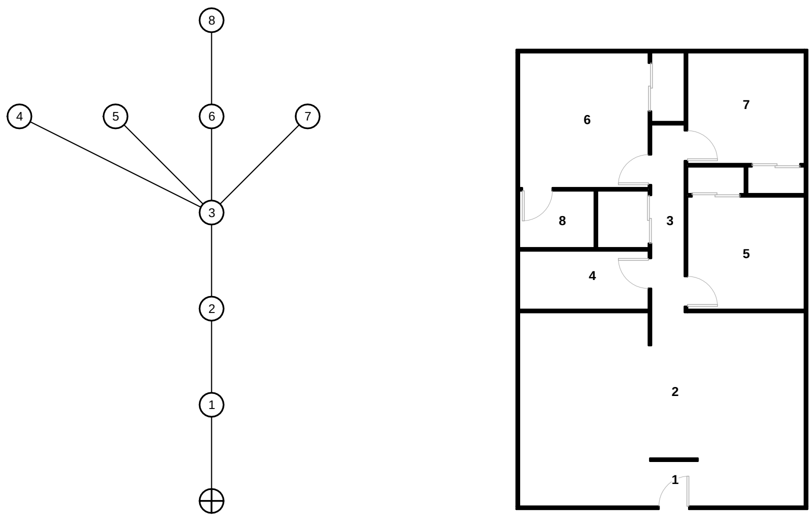


Table 3.7
Integration Values for Nukea House.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
2	**NUKEA**							
	OUTSIDE SPACE	⊕	3.375	9.000	0.679	0.317	2.141	0.467
	ENTRY	1	2.500	9.000	0.429	0.317	1.352	0.740
	LIVING ROOM / KITCHEN	2	1.875	9.000	0.250	0.317	0.789	1.268
	HALLWAY	3	1.500	9.000	0.143	0.317	0.451	2.219
	BATHROOM 1	4	2.375	9.000	0.393	0.317	1.239	0.807
	BEDROOM 1	5	2.375	9.000	0.393	0.317	1.239	0.807
	BEDROOM 2	6	2.125	9.000	0.321	0.317	1.014	0.986
	BEDROOM 3	7	2.375	9.000	0.393	0.317	1.239	0.807
	BATHROOM 2	8	3.000	9.000	0.571	0.317	1.803	0.555
	MEAN INTEGRATION				**0.397**		**1.252**	

Figure 3.8
87-111 Linakola Street
TMK: 187013005
Area: 1500 SF

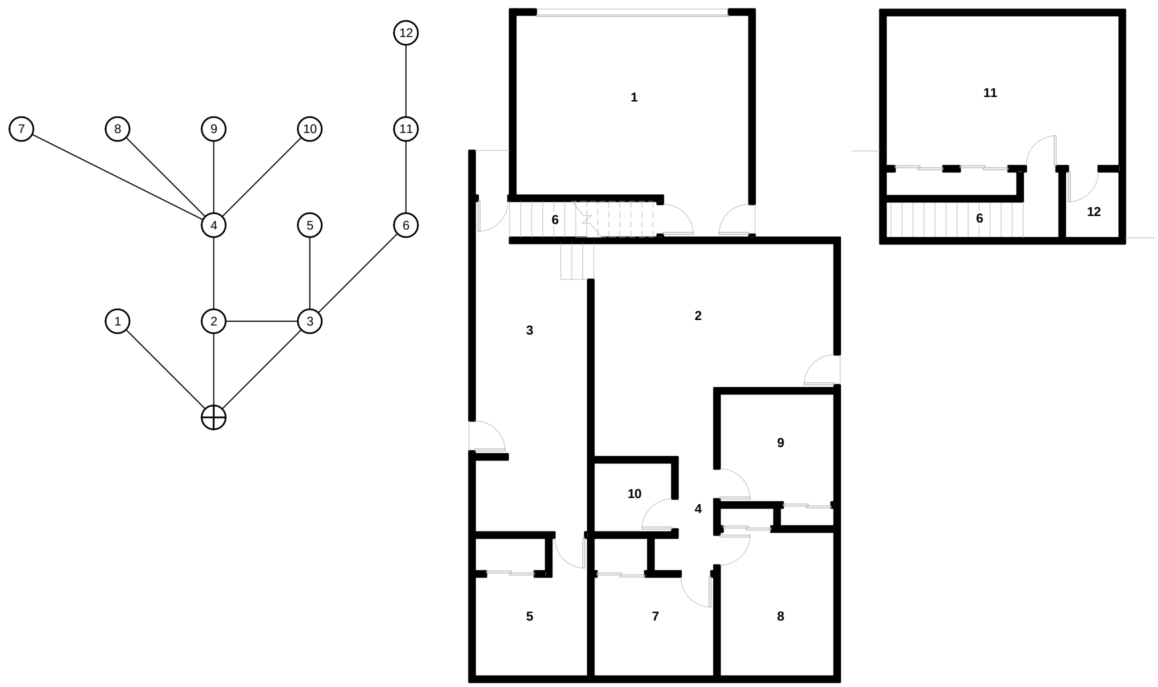


Table 3.8
Integration Values for Linakola House.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
1	**LINAKOLA**							
	OUTSIDE SPACE	⊕	2.333	13.000	0.242	0.276	0.878	1.139
	GARAGE	1	3.250	13.000	0.409	0.276	1.482	0.675
	LIVING ROOM / KITCHEN	2	2.000	13.000	0.182	0.276	0.659	1.518
	ENCLOSED PATIO	3	2.083	13.000	0.197	0.276	0.713	1.402
	HALLWAY	4	2.250	13.000	0.227	0.276	0.823	1.214
	BEDROOM 1	5	3.000	13.000	0.364	0.276	1.318	0.759
	STAIRWAY	6	2.667	13.000	0.303	0.276	1.098	0.911
	BEDROOM 2	7	3.167	13.000	0.394	0.276	1.428	0.701
	BEDROOM 3	8	3.167	13.000	0.394	0.276	1.428	0.701
	BEDROOM 4	9	3.167	13.000	0.394	0.276	1.428	0.701
	BATHROOM 1	10	3.167	13.000	0.394	0.276	1.428	0.701
	BEDROOM 5	11	3.417	13.000	0.439	0.276	1.592	0.628
	BATHROOM 2	12	4.333	13.000	0.606	0.276	2.196	0.455
	MEAN INTEGRATION				**0.350**		**1.267**	

Figure 3.9
87-1494 Farrington Highway
TMK: 187017070
Area: 1400 SF

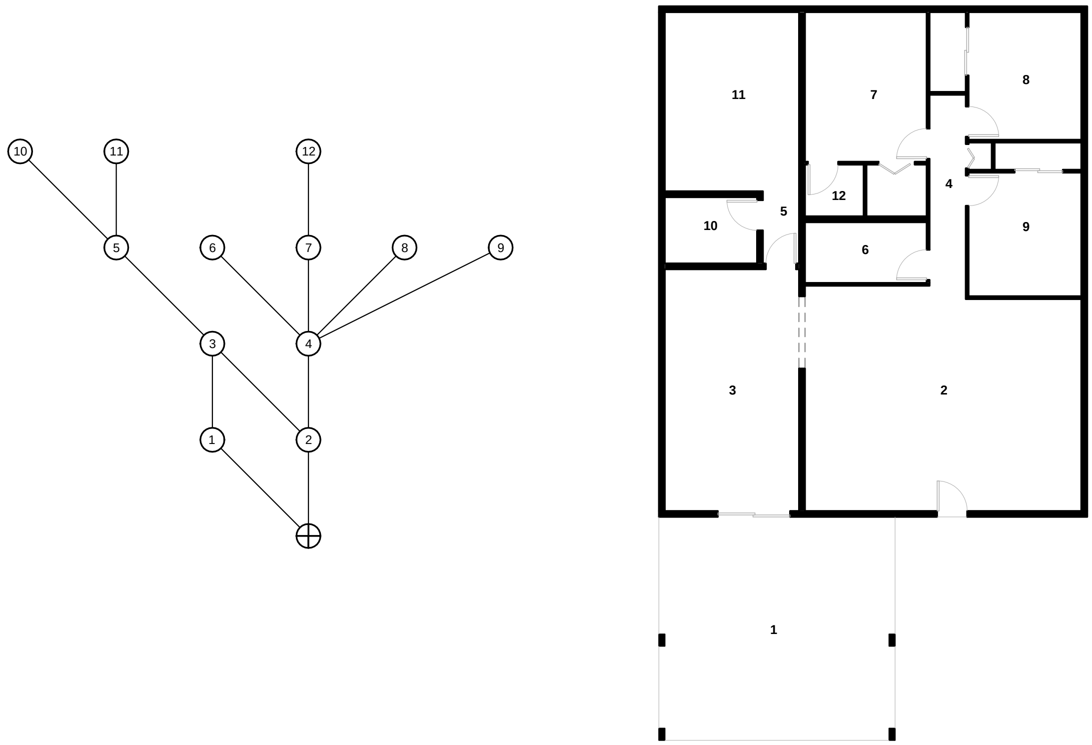


Table 3.9
Integration Values for Farrington House.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
3	**FARRINGTON**							
	OUTSIDE SPACE	⊕	2.750	13.000	0.318	0.276	1.153	0.867
	GARAGE	1	3.250	13.000	0.409	0.276	1.482	0.675
	LIVING ROOM / KITCHEN	2	2.000	13.000	0.182	0.276	0.659	1.518
	ENCLOSED PATIO	3	2.250	13.000	0.227	0.276	0.823	1.214
	HALLWAY 1	4	2.083	13.000	0.197	0.276	0.713	1.402
	HALLWAY 2	5	2.833	13.000	0.333	0.276	1.208	0.828
	BATHROOM 1	6	3.000	13.000	0.364	0.276	1.318	0.759
	BEDROOM 1	7	2.833	13.000	0.333	0.276	1.208	0.828
	BEDROOM 2	8	3.000	13.000	0.364	0.276	1.318	0.759
	BEDROOM 3	9	3.000	13.000	0.364	0.276	1.318	0.759
	BATHROOM 2	10	3.750	13.000	0.500	0.276	1.812	0.552
	BEDROOM 4	11	3.750	13.000	0.500	0.276	1.812	0.552
	BATHROOM 3	12	3.750	13.000	0.500	0.276	1.812	0.552
	MEAN INTEGRATION				**0.353**		**1.279**	

Figure 3.10
91-1010 Kuea Street
TMK: 191084027
Area: 1900 SF

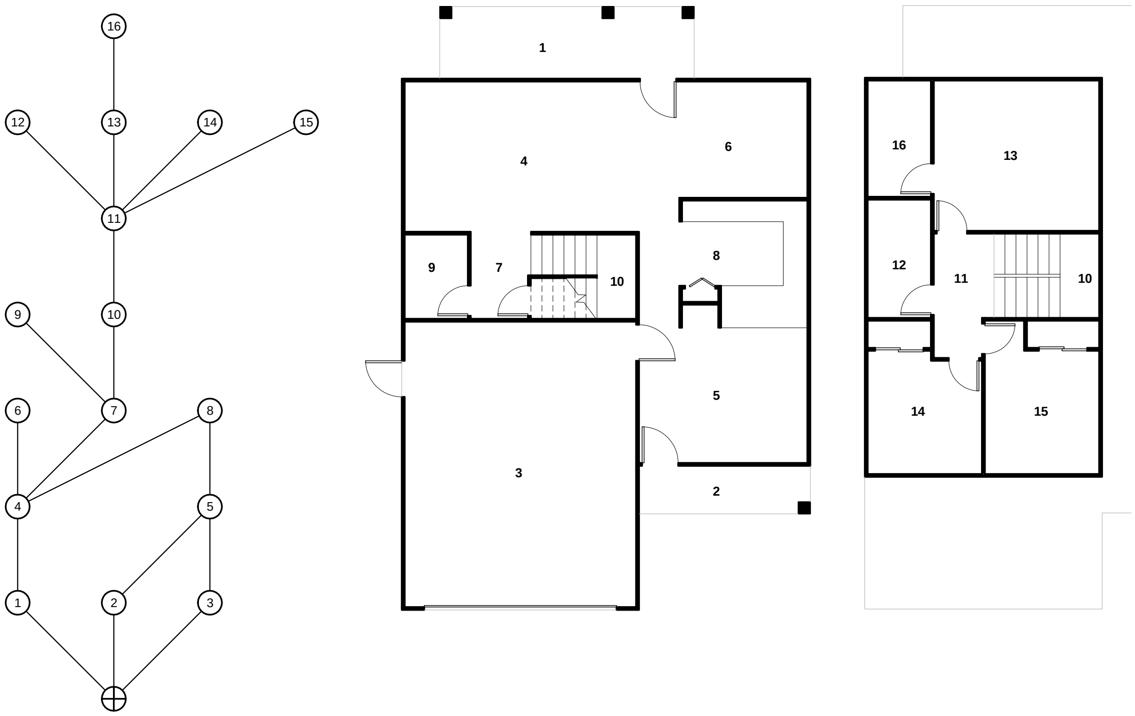
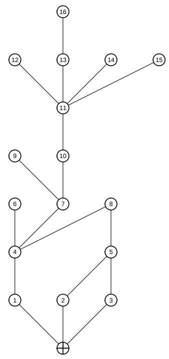


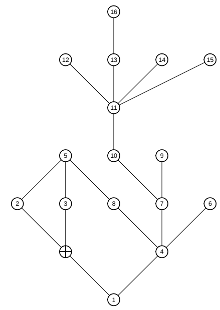
Table 3.10
Integration Values for Kuea House.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
6	**KUEA**							
	OUTSIDE SPACE	⊕	3.750	17.000	0.367	0.244	1.503	0.665
	PORCH	1	3.188	17.000	0.292	0.244	1.196	0.836
	LANAI	2	4.125	17.000	0.417	0.244	1.708	0.586
	GARAGE	3	4.125	17.000	0.417	0.244	1.708	0.586
	LIVING ROOM	4	2.625	17.000	0.217	0.244	0.888	1.126
	FAMILY ROOM	5	3.500	17.000	0.333	0.244	1.366	0.732
	DINING ROOM	6	3.563	17.000	0.342	0.244	1.401	0.714
	HALLWAY 1	7	2.563	17.000	0.208	0.244	0.854	1.171
	KITCHEN	8	3.188	17.000	0.292	0.244	1.196	0.836
	BATHROOM 1	9	3.500	17.000	0.333	0.244	1.366	0.732
	STAIRWAY	10	2.750	17.000	0.233	0.244	0.956	1.046
	HALLWAY 2	11	3.063	17.000	0.275	0.244	1.127	0.887
	BATHROOM 2	12	4.000	17.000	0.400	0.244	1.639	0.610
	BEDROOM 1	13	3.875	17.000	0.383	0.244	1.571	0.637
	BEDROOM 2	14	4.000	17.000	0.400	0.244	1.639	0.610
	BEDROOM 3	15	4.000	17.000	0.400	0.244	1.639	0.610
	BATHROOM 3	16	4.813	17.000	0.508	0.244	2.083	0.480
	MEAN INTEGRATION				**0.342**		**1.402**	

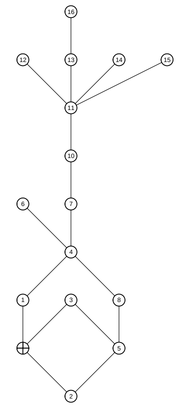
Outside Space



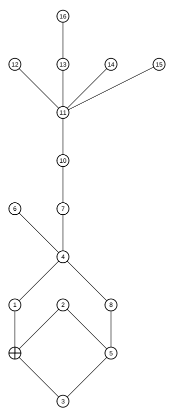
Space 1, Porch



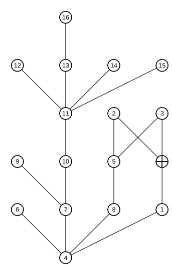
Space 2, Lanai



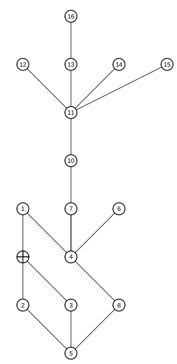
Space 3, Garage



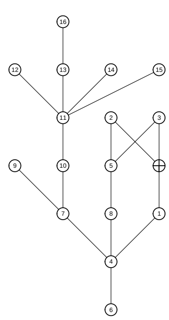
Space 4, Living Room



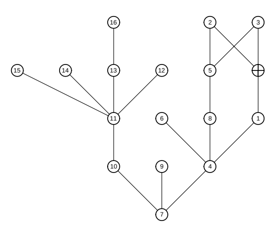
Space 5, Family Room



Space 6, Dining Room



Space 7, Hallway 1



Space 8, Kitchen

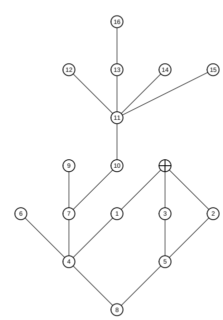
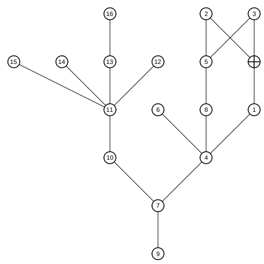
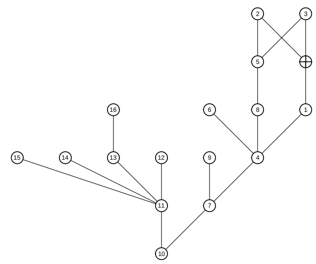


Table 3.11
Justified graphs of the outside space and spaces 1-8 for the Kuea home.

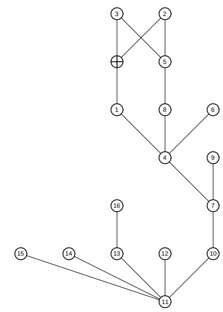
Space 9, Bathroom 1



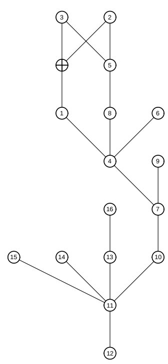
Space 10, Stairway



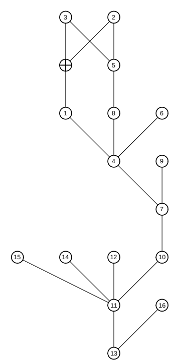
Space 11, Hallway 2



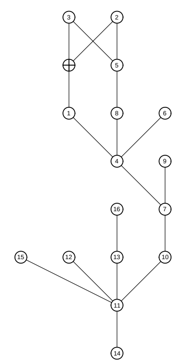
Space 12, Bathroom 2



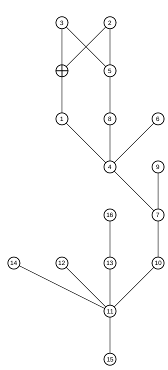
Space 13, Bedroom 1



Space 14, Bedroom 2



Space 15, Bedroom 3



Space 16, Bathroom 3

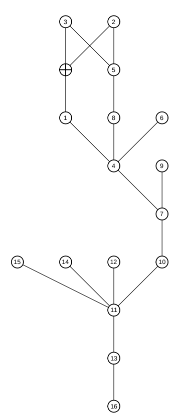


Table 3.11
Justified graphs of spaces 9-16 for the Kuea home.

Chapter Four: Analysis of Example House Types

This chapter offers some example applications of configuration analysis for several house types. The first two are drawn from *The social logic of space* and *Decoding Homes and House* to illustrate the use of space syntax. They also demonstrate how social implications can be drawn from the analysis as well as how syntactic parameters reflect known social conditions. The other three examples are house types from cultures that may be relevant to the analysis of single-family homes on Oahu.

19th Century English Cottage

The following example of analysis is drawn from (Hillier and Hanson 155-163).

The floor plan and justified graph of a late 19th century English cottage is presented as an example in (Hillier and Hanson 155) to illustrate the application of configuration analysis. A strong genotype for 19th century English homes can be derived from spatial relations consistently found across a large sample of varying building forms. These spatial relations are defined in terms of a certain family of spaces and a certain order of RA values. The genotype is not easily apparent by comparing floor plans. It is through the dissection of the interior spatial structures that the recurring generators of spatial patterns which make up the genotype can be identified.

The main rooms of the English house have markedly different RA values. The main rooms considered are the parlor, the kitchen, and the living room. The parlor is the best and least used room. Although the parlor is located at the front of the house next to the front door, it is the most segregated of the main rooms with the highest RA value. The kitchen has the second highest RA value, and the living room is the most integrated of the main rooms with the lowest RA value. The floor plan of the house along with its justified map is also presented for a conversion of the house in the 1960s. RA values are substantially lower in the transformed house with the exception of the carrier. However, the order of RA values for the main rooms is maintained despite the dramatic transformation.

The front parlor is considered a standard feature for English homes of this time period. It contains the best furniture and ornamentation of the house but is rarely used. The front parlor, despite its location at the front of the house, is often carefully hidden

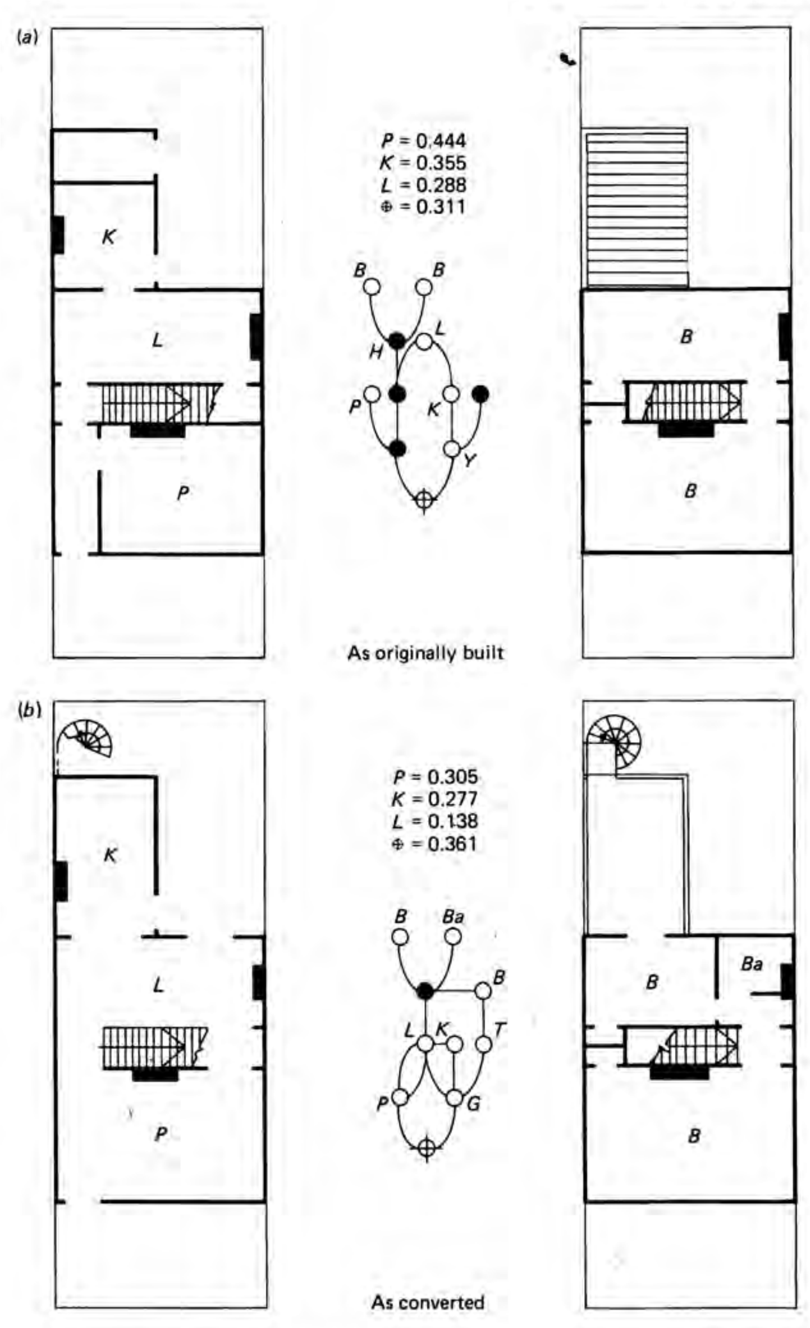


Figure 4.1
English cottage built in the 19th century (Hillier & Hanson 156).

from the street view by curtains. In addition, it is segregated from the rest of the house with the highest RA value. The prevalence of the front parlor in English homes and its isolation from its surroundings infers a transpatial solidarity. That is, the front parlor is a space that relates globally to other instances of its type through conformity rather than proximity. Transpatial solidarity of the front parlor is strengthened through isolation as is affirmed by its syntactic values (Hillier and Hanson 159).

The living room is the most used space in the house and the setting of everyday interactions and household activities. It is a space that all members of the household have equal access and equal rights. It is also the space where household members interact with neighbors, relatives, and other visitors. In order to serve these functions, the living room needs to be integrated with the rest of the house and located centrally on circulation paths. These requirements are expressed in the justified graph as well as its syntactic values.

This example illustrates the fundamental premise of space syntax that spatial order is a function of social solidarity. Social information is contained in the genotype of the English home and manifested in spatial forms and rules for different spaces in the configuration.

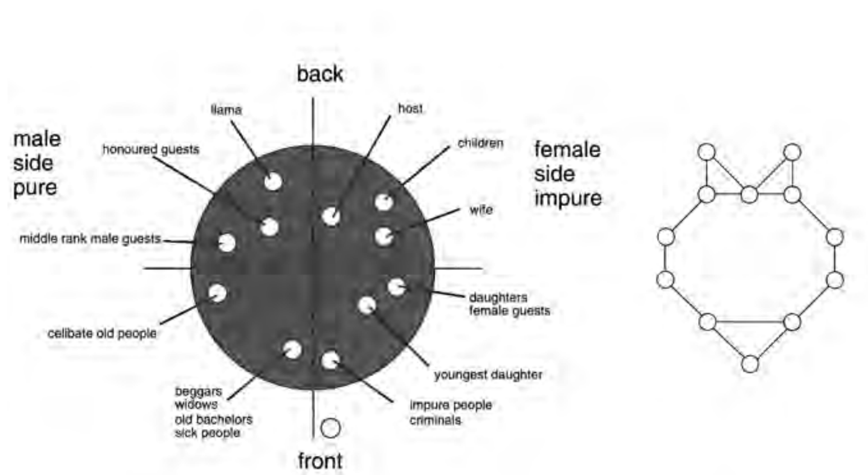


Figure 4.2
Mongolian yurt, people arrangement and justified graph (Hanson 45).

The Mongolian Yurt

The following example of analysis is drawn from (Hanson 11-12, 45).

The Mongolian yurt is an elaboration of the elementary building based on spatial dimensions that differentiate statuses amongst household members and guests. These spatial dimensions are front-back, left-right, high-low, center-periphery. Lacking interior subdivisions, the yurt's interior is organized without physical spatial boundaries. Within the yurt, everything has its place (Hanson 11). The relative position of objects and people are identical from one yurt to the next. The entrance to a yurt always faces south or southeast. Opposite the entrance, at the deepest space of the yurt, is the household shrine. The west is designated as the men's area and the women's to the east. The hearth is located at the center and household objects around the perimeter of the yurt. Daily life is rigidly and formally organized.

At first glance, the Mongolian yurt seems to be a simple domed structure with a lack of interior subdivisions (Hanson 45). However, the location of people and objects within the domestic interior is dictated by strong social conventions. Persons of higher statuses are positioned deeper into the yurt (Hanson 46). Persons who play more prominent roles in proceedings are positioned closer to the center of the yurt. Although the yurt is symmetrical and circular in plan, the position of individuals are skewed so that men appear to be located deeper than the women of an equal positions. Guests are given more prominence than family members. The position of individuals are marked on the ground by skins and felt mats or associated with household objects.

Even without interior boundaries, these locations can be translated into elements in a configuration model. The spatial relations of a Mongolian yurt can be plotted on a justified graph in order to better understand the social information that it contains. Instead of rooms, nodes on the justified graph represent people position. The lines joining these nodes represent proximity relations.

The justified graph and integration values reveal the complex hierarchy of the Mongolian yurt to be much more symmetrical than it first appeared. The position of the household head is the most influential. It is the most integrated and controls relations between his guests and family members. Around the household head, positions are paired and balanced in the graph. The integration values of people positions become more segregated as they near the outside space. This abstract configuration model is simpler but more informative of social roles within the Mongolian home than is shown in the plan diagram.

Figure 4.3
Floor plan of a Chinese rural house (Knapp 49) and justified graph.

Table 4.1
Integration values of Chinese rural house.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
1a	**Example Chinese 3**							
	OUTSIDE SPACE	⊕	4.765	18.000	0.471	0.237	1.986	0.504
	ENTRY	1	3.824	18.000	0.353	0.237	1.489	0.671
	VERANDA	2	3.000	18.000	0.250	0.237	1.055	0.948
	COURTYARD 1	3	3.941	18.000	0.368	0.237	1.551	0.645
	MAIN HALL	4	2.529	18.000	0.191	0.237	0.806	1.240
		5	3.941	18.000	0.368	0.237	1.551	0.645
	BEDROOM 1	6	3.118	18.000	0.265	0.237	1.117	0.895
	HALL	7	2.412	18.000	0.177	0.237	0.745	1.343
	BEDROOM 2	8	2.882	18.000	0.235	0.237	0.993	1.007
	KITCHEN 1	9	3.000	18.000	0.250	0.237	1.055	0.948
	COURTYARD 2	10	3.353	18.000	0.294	0.237	1.241	0.806
	KITCHEN 2	11	2.765	18.000	0.221	0.237	0.931	1.074
	STAIRWAY 1	12	3.824	18.000	0.353	0.237	1.489	0.671
	STAIRWAY 2	13	3.353	18.000	0.294	0.237	1.241	0.806
	BEDROOM 3	14	4.765	18.000	0.471	0.237	1.986	0.504
	HALLWAY	15	4.059	18.000	0.382	0.237	1.613	0.620
	BEDROOM 4	16	5.000	18.000	0.500	0.237	2.110	0.474
	BEDROOM 5	17	5.000	18.000	0.500	0.237	2.110	0.474
					0.330		*1.393*	

Table 4.2
Integration values of Chinese rural house without the outside space.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
1b	Without Carrier							
	ENTRY	1	4.000	17.000	0.400	0.244	1.639	0.610
	VERANDA	2	3.063	17.000	0.275	0.244	1.127	0.887
	COURTYARD 1	3	4.000	17.000	0.400	0.244	1.639	0.610
	MAIN HALL	4	2.500	17.000	0.200	0.244	0.820	1.220
		5	4.000	17.000	0.400	0.244	1.639	0.610
	BEDROOM 1	6	3.063	17.000	0.275	0.244	1.127	0.887
	HALL	7	2.313	17.000	0.175	0.244	0.717	1.394
	BEDROOM 2	8	2.813	17.000	0.242	0.244	0.991	1.009
	KITCHEN 1	9	2.875	17.000	0.250	0.244	1.025	0.976
	COURTYARD 2	10	3.250	17.000	0.300	0.244	1.230	0.813
	KITCHEN 2	11	2.625	17.000	0.217	0.244	0.888	1.126
	STAIRWAY 1	12	3.688	17.000	0.358	0.244	1.469	0.681
	STAIRWAY 2	13	3.188	17.000	0.292	0.244	1.196	0.836
	BEDROOM 3	14	4.625	17.000	0.483	0.244	1.981	0.505
	HALLWAY	15	3.875	17.000	0.383	0.244	1.571	0.637
	BEDROOM 4	16	4.813	17.000	0.508	0.244	2.084	0.480
	BEDROOM 5	17	4.813	17.000	0.508	0.244	2.084	0.480
					0.315		*1.290*	

Chinese Rural House

This example is a Chinese rural house in Hangzhou, China. It is home to two families and illustrates a fairly structured configurational layout. The intention is not to suggest that the local culture on Oahu is similar to the Chinese culture, but to offer a point of reference for comparison.

A traditional Chinese house is a walled compound with rooms organized around a series of courtyards. The open space of the courtyard are trees, other plants, and ponds. They are also areas where animals such as chickens and pigs are kept. The rooms are often connected by verandas. It is common for more than one family to occupy a house. Courtyards in the front and back are characteristic of these homes (Knapp 49).

The Chinese rural house has a narrow tree-like graph. Its integration values differ marginally with and without the outside space. This implies that the configuration is organized to structure interior relationships and inhabitant-inhabitant interface. Furthermore, the outside space is extremely segregated from the rest of the house. It's integration value, RRA = 1.986, is nearly twice as segregated as the outside space of a typical home on Oahu, average RRA = 1.150. The courtyards of the Chinese rural house may serve the same functions as the carrier of the Oahu home, but distinctly different from the carrier of its own configuration. The high RRA value of the outside space can also be an indicator of a configuration structured for interior relationships. This suggests that privacy is much more desirable in the Chinese rural house than it is for a standard home on Oahu. It may also suggest that the exterior of the Chinese rural house is much less utilized than is the exterior space of a typical home on Oahu.

The integration value of the primary gathering space in the Chinese rural house, the Main Hall with an RRA = 0.806, is similar to that of the living room in a typical home on Oahu, average RRA = 0.779. Although the Main Hall and the Living Room have relatively low RRA values, neither are the most integrated and share similar integration rankings. This suggests that the Main Hall and the Living Room serve similar functions.

The Main Hall of the Chinese rural house is twice as deep, depth = 3, as a typical living room of a house on Oahu, average depth = 3. The primary gathering space is much more private in a Chinese rural house when compared to homes on Oahu.

The integration values of the bedrooms in the Chinese rural house differ significantly when compared with the typical home on Oahu. In the Chinese rural house, the most integrated bedroom, RRA = 0.993, is more than twice as integrated as the most segregated bedroom, RRA = 2.110. In a house on Oahu, North Shore – Leleuli, the most integrated bedroom, RRA = 1.100, differs marginally from the most segregated bedroom, RRA = 1.404. This suggests that family structures on Oahu are less hierarchical than those of rural China.

Figure 4.4
Floor plan of Cebuan Filipino Dwelling in Caticugan (Hart 86) and justified graph.

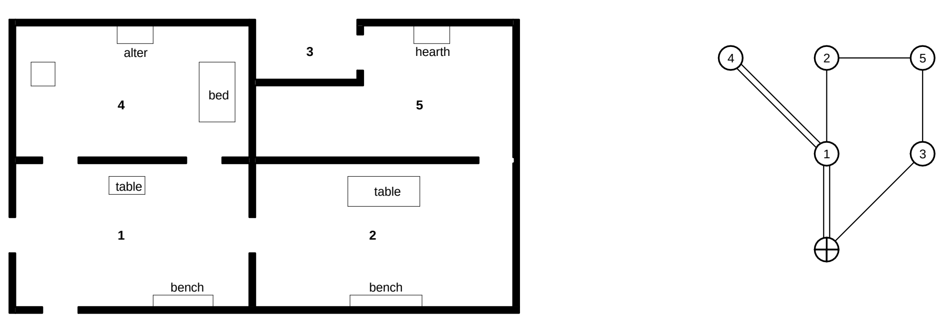


Table 4.3
Integration values of Filipino dwelling.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
2a	**Example Filipino 1**							
	OUTSIDE SPACE	⊕	1.600	6.000	0.300	0.349	0.860	1.163
	LIVING ROOM	1	1.800	6.000	0.400	0.349	1.146	0.873
	DINING ROOM	2	1.600	6.000	0.300	0.349	0.860	1.163
	REAR ENTRY	3	1.800	6.000	0.400	0.349	1.146	0.873
	BEDROOM	4	2.200	6.000	0.600	0.349	1.719	0.582
	KITCHEN	5	1.800	6.000	0.400	0.349	1.146	0.873
					0.400		*1.146*	

Table 4.4
Integration values of Filipino dwelling without the outside space.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
2b	Without Carrier							
	LIVING ROOM	1	1.750	5.000	0.500	0.352	1.420	0.704
	DINING ROOM	2	1.500	5.000	0.333	0.352	0.947	1.056
	REAR ENTRY	3	2.500	5.000	1.000	0.352	2.841	0.352
	BEDROOM	4	2.500	5.000	1.000	0.352	2.841	0.352
	KITCHEN	5	1.750	5.000	0.500	0.352	1.420	0.704
					0.667		*1.894*	

Filipino Dwelling in Caticugan

The Cebuan dwelling of Caticugan provides a simple illustration of a house that is very connected to the outside space. They are rural dwellings made of light materials such as bamboo, palms, and cogon. This particular example houses a family of 8. The living room, or sala, is the main space of the house. It is where guests are entertained, where the alter is kept, and where the best furniture is placed (Hart 86).

The Filipino dwelling has a shallow graph with multiple links to the outside space. The mean integration value, RRA = 1.146, is considerably affected when the outside space is not considered, RRA = 1.894. This suggests that the configuration is organized to structure inhabitant-visitor relationships. Without the outdoor space, the graphs from each space becomes much more linear overall. For the Filipino dwelling, RRA increases by 65%. For a house on Oahu, North Shore – Leleuli, RRA remained virtually unchanged, from 1.148 to 1.142. The outdoor space holds little significance in the circulation of this house on Oahu. Paths between spaces rarely pass through the exterior. The outdoor space in the Filipino dwelling places a much more significant role than it does in a typical home on Oahu.

The integration value of the living room in a typical Ohau home, average RRA = 0.779, is considerably lower than that of the living room of the Filipino dwelling, RRA = 1.146. Surprisingly, the living room of a typical home on Oahu is more integrated than that of the Filipino dwelling. This is due mostly to the significantly larger number of spaces in the overall configuration that are linked to the living room in most of the Oahu homes. Integration values only indicate likelihood and favorability of a space for gathering. Other factors should also be considered. This suggests that the living room of a typical home on Oahu is more conducive to gathering than the living room of the Filipino dwelling.

The spaces with the lowest integration values in the Filipino dwelling are the outside space and the dining room, RRA = 0.860. On the average, the space that is most integrated for Oahu homes is the hallway, average RRA = 0.647. The second lowest is the living room, average RRA = 0.779. Where the outside space and dining room of the Filipino dwelling are arguably appropriate spaces for gathering, the hallway of an Oahu home is not. This conclusion points out a disconnect between configuration and use of space for homes on Oahu.

The mean integration value of the Filipino dwelling, RRA = 1.146, is very similar to that of a typical home on Oahu, average mean RRA = 1.163. Although the mean integration values are similar, distribution of integration varies significantly between the Filipino dwelling and the typical home on Oahu. Variation in integration is minimal

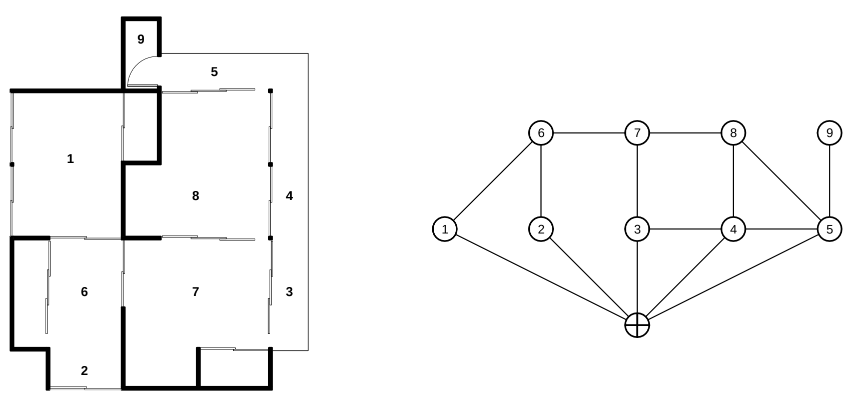


Figure 4.5
Floor plan of Japanese House (Bevier) and justified graph.

Table 4.5
Integration values of Japanese house.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
3a	**Example Japanese 1**							
	OUTSIDE SPACE	⊕	1.444	10.000	0.111	0.306	0.363	2.757
	KITCHEN	1	2.000	10.000	0.250	0.306	0.817	1.224
	ENTRY	2	2.000	10.000	0.250	0.306	0.817	1.224
	PORCH	3	1.778	10.000	0.195	0.306	0.636	1.573
	PORCH	4	1.667	10.000	0.167	0.306	0.545	1.835
	PORCH	5	1.667	10.000	0.167	0.306	0.545	1.835
	ANTE-ROOM	6	2.111	10.000	0.278	0.306	0.908	1.102
	LIVING ROOM	7	1.778	10.000	0.195	0.306	0.636	1.573
	LIVING ROOM	8	1.889	10.000	0.222	0.306	0.726	1.377
	BATHROOM	9	2.556	10.000	0.389	0.306	1.271	0.787
					0.222		*0.726*	

Table 4.6
Integration values of Japanese house without the outside space.

	SPACE	NO.	MD	K	RA	D-VALUE	RRA	Integration Value
			(MEAN DEPTH)	(NO. OF SPACES)	(RELATIVE ASSYMETRY)	(HILLIER & HANSON 112)		
3b	**Example Japanese 1**							
	Without Carrier							
	KITCHEN	1	3.000	9.000	0.571	0.317	1.803	0.555
	ENTRY	2	3.000	9.000	0.571	0.317	1.803	0.555
	PORCH	3	2.125	9.000	0.321	0.317	1.014	0.986
	PORCH	4	2.250	9.000	0.357	0.317	1.127	0.888
	PORCH	5	2.250	9.000	0.357	0.317	1.127	0.888
	ANTE-ROOM	6	2.125	9.000	0.321	0.317	1.014	0.986
	LIVING ROOM	7	1.750	9.000	0.214	0.317	0.676	1.479
	LIVING ROOM	8	1.875	9.000	0.250	0.317	0.789	1.268
	BATHROOM	9	3.125	9.000	0.607	0.317	1.915	0.522
					0.397		*1.252*	

in the spaces of the Filipino dwelling compared to the homes on Oahu. In the Filipino dwelling, the living room, rear entry, and kitchen have the same integration values. The use of space in a typical home on Oahu varies much more significantly when compared to the Filipino dwelling.

The bedrooms of both the Filipino dwelling and the average Oahu home is the least integrated space. The bedroom of the Filipino dwelling, RRA = 1.719, is more segregated than the bedroom of an Oahu home, North Shore – Leleuli, average RRA = 1.29. In the Filipino dwelling, sleeping also occurs in the living room. The bedrooms of both the Filipino dwelling and average home on Oahu is configured appropriately for similar functions.

Japanese House

The walls of the Japanese House are made of sliding shutters and can also serve as doors. Each room is laid out in modules of 3' x 6' mats. Bedrooms are not necessary as sleeping can take place in any of the rooms by laying down thick comforters on the mats. Chairs and tables are rarely used (Bevier).

The Japanese house has a ringy configuration graph with multiple links to the outside space. The mean integration value of the Japanese house, RRA = 0.726, is significantly lower than the average mean integration value of homes on Oahu, average mean RRA = 1.163. The Japanese house also has a lower mean integration value than the most integrated Oahu home, Makakilo – Hookeha, mean RRA = 0.845. The spaces in a typical home on Oahu are much more segregated than those of the Japanese house. Compared to the Oahu home, it is much easier in the Japanese home to move from one space to another. Overall, the spaces in the Japanese home are also more conducive to gathering. This is furthered by the multipurpose use of the spaces in the Japanese house.

The mean integration value of the Japanese house, RRA = 0.726, changes significantly when the outside space is not considered, RRA = 1.252. That is a 72% increase in RRA value when the outside space is omitted from the configuration. The exterior of the Japanese house places a much more significant role in the circulation of the house when compared to homes on Oahu.

Furthermore, the integration value of the outside space of the Japanese house, RRA = 0.363, is significantly lower than that of the average home on Oahu, average RRA = 1.150. It is over three times more integrated. The exterior of the Japanese house is a much more integral part of the household activities when compared to homes on Oahu. This is apparent in the floor plan and is also supported by the significance of the garden in the Japanese house.

Chapter Five: Conclusions

Space syntax analysis effectively illustrates the disconnect between the architecture and culture of Oahu's domestic environments in its underlying spatial structure. By computation and analysis of integration values, spatial relationships are made apparent and conclusions can be drawn for recurring configurational characteristics. The analysis identifies three configurational characteristics that decisively indicate disparities between spatial structure and cultural values.

First, the spatial configuration of the typical home on Oahu does not relate well with the exterior. Given Oahu's moderate climate, much of the local culture is fitting with the natural outdoors. Many common gathering activities take place in domestic outdoor spaces (e.g. carports, backyards, patio decks, etc.) even as they are not configured appropriately for gathering. These spaces, as shown by the analysis, are segregated from the rest of the house and only become used for gathering when a conscious intention is made.

The exterior spaces associated with the house is considerably segregated from the interior spaces. The carport/garage and the carrier (outdoor space) is often ranked the most segregated when bedrooms and bathrooms are excluded. This is true in 6 of the 10 homes in the Oahu sample. In the other four, they are nonetheless at the high end of the range of RRA values. The average RRA value of the outside space is 1.150, and the carport/garage averages 1.117. Both of these figures – higher than 1.0 – are considered strongly segregating values.

The living room of the standard Oahu home is significantly more conducive to gathering than any exterior space. In the analysis, the living room is consistently ranked as the first or second most integrating space in the sample of Oahu homes. The average RRA value of the living room is 0.779 compared to 1.150 of the outside space. The implication is not to segregate the living room, but to integrate the outdoor space to a level closer to that of the living room.

Comparative analysis of the Chinese rural house with the Oahu sample further indicates a strong focus on interior over exterior spaces. The outdoor space of the Chinese rural house is significantly more segregated than that of the average Oahu home, but both are nonetheless interior oriented configurations. Other similarities are shared in their overall configurations.

There is a similarity in mean integration values that is also reflected visually in their justified graphs. In addition, the primary gathering space of both – the Chinese main hall and the Oahu living room – have very similar integration values. The Chinese rural house is undoubtedly an interior oriented configuration of which the standard Oahu home shares many characteristics.

The second configurational characteristic identified in the analysis suggests a formal rigidity in the underlying spatial structure of Oahu homes. It is the functional differentiation of spaces within the Oahu home. Functional differentiation implies intentional structuring of spaces for specific uses. The formal structuring of space for Oahu homes is somewhat contrary to the largely casual nature of the local culture.

In this aspect, the Oahu home again shares similarities with the Chinese rural house. Differentiation of function can be inferred by differentiation in integration values. The mean integration value of a configuration model can be used as a benchmark to gauge the extent of differentiation for each individual space in the configuration. For the Chinese rural house, the difference between individual integration values and the mean integration value of the configuration is significant for a large majority of the spaces in the configuration. Functional differentiation of space is characteristic of the Chinese rural house, especially when compared with the Japanese house and the Filipino dwelling examples. This is also true of the Oahu home but to a considerably lesser extent.

The analysis also reveals a hierarchy in the family structure of the Oahu home that is reflected in its configuration, specifically the differentiation of bedrooms. Certain bedrooms are associated with certain members of the household, and functional differentiation of these bedrooms imply differentiation of roles and thus hierarchy. In the sample of Oahu homes analyzed, certain bedrooms are consistently differentiation from the others.

Often, it is the master bedroom. The Chinese rural house also shares this characteristic in bedrooms but in a much more pronounced manner. Household hierarchy is another aspect of the Oahu home that points to a formal configurational structure.

The third configurational characteristic and indicator of the spatial-cultural disparity refers to the incongruous structuring of spaces for their actual uses. Integration values often suggests certain attributes for a space. Lower RRA values – higher integration – may imply functional significance, frequent use, or higher activity. In the Oahu sample of homes analyzed, three spaces exhibit this configuration characteristic – the hallway, kitchen, and the carport/garage.

Table 5.1
Summary of integration values for the sample of homes on Oahu. The RRA of the main spaces are listed. Higest ranking RRA is highlighted in red, and the lowest ranking RRA is highlighted in blue.

			MEAN	OUTSIDE SPACE	LIVING ROOM	FAMILY ROOM	KITCHEN	HALLWAY	HALLWAY 2	CARPORT	CARPORT 2
INTEGRATION											
1	LINAKOLA		1.267	0.878	0.659		0.659	0.823		0.675	
2	NUKEA		1.252	2.141	0.789		0.789	0.451			
3	FARRINGTON		1.279	1.153	0.659		0.659	0.713	1.208	1.482	
4	HANA		1.066	0.718	0.885	1.292	1.005	0.622	0.622	0.933	1.172
5	LAUKONA		1.222	1.230	0.721		0.721	1.018	0.721		
6	KUEA		1.402	1.503	0.888	1.366	1.196	0.854	1.127	1.708	
7	MAKAALO		0.916	1.043	1.318	0.604	0.878	0.329		0.713	
8	HOOKEHA		0.845	0.893	0.510		1.021	0.319		0.702	
9	PALEKANA		1.230	1.148	0.789	1.555	1.555	0.622	0.909	1.603	
10	LELEULI		1.148	0.797	0.569	1.632	1.252	0.721	0.873		
	AVERAGE		*1.163*	*1.150*	*0.779*		*0.974*	*0.647*		*1.117*	*0.117*

In a significant majority of homes analyzed for Oahu, the hallway is the most integrated space. The average RRA value is 0.647. Furthermore, many configurations feature more than one hallway. The consistency in the ranking of the hallway as the most integrated space suggests that it is intentionally a space of great significance to the house. The hallway, however, holds very little relevance to local cultural values. An inappropriate amount of focus is directed at the hallway in a standard home on Oahu.

The RRA values of the kitchen for the sample analyzed tends to be on the higher end of the spectrum with an average RRA of 0.974. A value of 1.0 or higher is considered to be strongly segregating. In cases where the kitchen opens up directly to the living room, both spaces are treated as one, sharing the same integration value. This has the effect of lowering the average RRA value of the kitchen for the sample. Kitchens separated from the living room are in all cases more segregated. Food is often thought of as an important part of the local culture, its variety reflecting the different ethnic backgrounds of Oahu residents. The kitchen then becomes an important gathering space for family and friends. However, configuration analysis indicates that it is often segregated from the other spaces and plays a minimal role in the spatial configuration of the house.

The carport/garage is arguably the most notable example of misuse of space in the Oahu home. They are intended for automobile storage, and their spatial configuration is structured as such. However, Oahu residents very frequently utilize the carport/garage as a place for family gatherings. The use of the carport/garage as a gathering space is not attributed to its spatial relationships to the rest of the house but to climatic influences and programmatic needs. From the analysis, the carport/garage of the Oahu home is a strongly segregated space with an average RRA value of 1.117. It is perhaps one of the most significant spaces for consideration in the exploration of alternative configuration models for the Oahu home.

Spatial configuration analysis revealed some expected characteristics of the single-family home on Oahu as well as some that are not so obvious. Most notable is the segregation of the interior spaces from the exterior. The theme of indoor-outdoor spaces in the domestic environment is frequently talked about but is not exemplified in the sample analyzed. The analysis further reveals that Oahu homes are formally structured configurations. In the context of the local culture, spatial configuration alternatives may lead to the design of homes that are more fitting to our lifestyle. Less surprisingly, many spaces of the Oahu home are not appropriately structure for their actual uses. In this study, configurational analysis also affirms some already known social qualities of space. In conclusion, Space Syntax substantiates a perception amongst the design community as well as the general public – that our homes are designed after generic models insensitive to cultural and social needs.

Although Space Syntax provides a set of principles and techniques for analysis that has yielded useful results in this study, there are several points of criticism worth mentioning. First, size of space is not factored in the analysis. It may perhaps be intentionally excluded to focus on relationships between spaces rather than space itself. However, size of space can be seen as an indicator of its significance to the overall configuration and has bearing on spatial relationships. Furthermore, size of a space affects functional qualities – privacy, quietness, frequency of use, etc. Another criticism is the homogenous treatment of the links that connect individual spaces in the configuration. The nature of transitions can have a strong influence on the experience of a building. Factoring in a quantitative description of spatial links into the calculation of syntactic parameters – integration value, control, etc. – can significantly add to the analysis. These points and the possibility of adapting the method for different needs can lead to further understanding of the method in future works.

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